Table of contents

1 Introduction 1–1

1.1 About the PV 403 ventilator 1–1
1.1.1 Function 1–1
1.1.2 Intended use 1–2
1.1.3 Construction 1–2
1.1.4 Power failure alarm 1–2
1.1.5 Calendar Data Analysis software 1–2
1.1.6 Service personnel's training requirements 1–2
1.2 About this manual 1–3
1.2.1 Scope 1–3
1.2.2 Intended audience 1–3
1.2.3 Icons 1–3

2 Maintenance instructions 2–1

2.1 Purpose 2–1
2.2 Introduction 2–1
2.2.1 Service schedule 2–2
2.2.2 Safety precautions 2–3
2.2.3 Service record 2–3
2.2.4 Inspection equipment and tools 2–3
2.2.5 Replacement parts 2–3
2.3 Preparing for inspection 2–4
2.3.1 Verifying the components and the installed software 2–4
2.3.2 Initial recording 2–4
2.3.3 Checking additional services 2–4
2.3.4 Inspecting the markings 2–4
2.3.5 Information from the patient/user 2–5
2.3.6 Validity of the documentation 2–5
2.4 External inspection 2–5
2.4.1 Visual inspection for external damage and wear 2–5
2.4.2 Checking the power connection 2–5
2.4.3 Minimum function check 2–5
2.5 Internal inspection 2–6
2.5.1 Cleaning the inside of the ventilator 2–6
2.5.2 Checking the cables 2–6
2.5.3 Checking the fastening of components 2–6
2.5.4 Replacing the drive belt 2–6
2.5.5 Lubricating the ball screw 2–6
2.5.6 Replacing the membrane assemblies in the check valves 2–6
2.5.7 Checking the power supply 2–6
2.5.8 Calibrating the pressure sensors 2–6
2.5.9 Reassembling the casing 2–6

2.5.10 Electrical safety 2–6
2.5.11 Testing for leakage of the tubes and bellows 2–7
2.6 Final inspection 2–7
2.6.1 Function check 2–7
2.6.2 Checking the leakage alarm for low pressure 2–7
2.6.3 Checking the low-volume alarm 2–7
2.6.4 Checking the alarm mute 2–7
2.6.5 Checking the trigger 2–7
2.6.6 Checking the pressure/rate 2–7
2.6.7 Checking the tidal volume indication 2–8
2.6.8 Checking the tidal volume (VCV mode) 2–9
2.6.9 Checking external battery operation 2–9
2.6.10 Checking internal battery operation 2–9
2.6.11 Inspecting the patient circuit 2–9
2.6.12 Replacing the membrane assembly in the exhalation valve 2–10
2.6.13 Cleaning the PEEP valve adapter 2–11
2.6.14 Inspecting the ventilator accessories 2–12
2.6.15 Changing/washing the patient filters 2–12
2.6.16 Adjusting the settings for the patient 2–12

3 Parts location 3–1

3.1 Parts drawing 1 – Main components 3–2
3.2 Parts drawing 2 – Motor, circuit boards, and transformer 3–4
3.3 Parts drawing 3 – Casings, panels, labels, valves, filters 3–5
3.4 Parts drawing 4 – Motor assembly 3–6
3.5 Parts drawing 5 – Tubes and connections 3–7
3.6 Parts list for PV 403 and PV 403 PEEP 3–8

4 Functional diagrams 4–1

4.1 Functional block diagram PV 403 4–1
4.2 Functional block diagram PV 403 PEEP 4–2
4.3 Pneumatic diagram PV 403 4–3
4.4 Pneumatic diagram PV 403 PEEP 4–4

5 Removing and replacing the main components 5–1

5.1 Removing the upper casing 5–1
5.2 Removing and replacing the push-button panel 5–2
5.3 Removing and replacing the alarm board 5–3
5.4 Removing and replacing the CPU board 5–4
5.5 Installing the internal battery kit (accessory) 5–5
5.5.1 Internal battery kit 5–5
5.5.2 Internal battery operation 5–5

5.5.3 Installing the internal battery pack ... 5–6
5.5.4 Removing the internal battery pack ... 5–6
5.6 Removing and replacing the PGC board ... 5–7
5.7 Removing and replacing the PEEP compressor ... 5–8
5.8 Location of the air tubes ... 5–9
5.9 Removing and replacing the rear panel ... 5–10
5.10 Removing and replacing the I/O board ... 5–11
5.11 Removing the motor assembly from the lower casing ... 5–12
5.12 Reassembling and replacing the motor assembly ... 5–13

6 Motor assembly ... 6–1

6.1 Main components of the motor assembly ... 6–2
6.2 Removing the motor assembly ... 6–3
6.3 Inspecting and replacing the driving belt ... 6–3
6.4 Lubricating the ball screw ... 6–3
6.5 Replacing the membranes in the check valves ... 6–5
6.5.1 Equipment ... 6–5
6.5.2 Replacing the check valve membrane under the air channel ... 6–5
6.5.3 Replacing the check valve membrane in the patient air outlet ... 6–7
6.6 Testing for leakage from the tubes and bellows ... 6–8
6.6.1 With open ventilator casing ... 6–8
6.6.2 With closed ventilator casing ... 6–9
6.7 Replacing the ball screw assembly ... 6–10
6.8 Replacing the bearing housing assembly ... 6–12

7 Pressure calibration and firmware upgrade ... 7–1

7.1 Introduction to the pressure calibration process ... 7–1
7.1.1 Calibration process ... 7–1
7.1.2 Calibration equipment ... 7–2
7.1.3 Pressure sensors ... 7–2
7.1.4 Installing the calibration software ... 7–3
7.2 Starting the calibration ... 7–4
7.2.1 Requirements ... 7–4
7.2.2 Starting the calibration ... 7–4
7.2.3 Adjust pressure PV 403 window ... 7–6
7.3 Manual adjustment ... 7–7
7.3.1 Starting the manual adjustment ... 7–7
7.3.2 Adjusting the G2 pressure sensor ... 7–8
7.3.3 Adjusting the G1 pressure sensor ... 7–8
7.3.4 Verifying the calibration of the pressure sensors ... 7–9
7.4 Automatic adjustment ... 7–10

7.4.1 Starting the automatic adjustment 7–10
7.4.2 Verifying the automatic adjustment 7–11
7.5 Upgrading the PV 403 firmware 7–12
7.5.1 Starting the upgrade 7–12
7.5.2 Upgrading the CPU board and alarm board firmware 7–13

8 Electronics 8–1

8.1 Functional block diagram PV 403 8–1
8.2 Functional block diagram PV 403 PEEP 8–2
8.3 Main components 8–3
8.4 Main cabling diagram PV 403 8–5
8.5 Main cabling diagram PV 403 PEEP 8–6
8.6 Circuit board descriptions 8–7
8.6.1 Push-button membrane panel 8–7
8.6.2 LCD display 8–7
8.6.3 Alarm board 8–8
8.6.4 CPU board 8–9
8.6.5 PGC (Pressure Gauge Card) board 8–11
8.6.6 I/O (Input/Output) board 8–12
8.7 Test points – CPU board 8–13
8.7.1 Test point locations 8–13
8.7.2 Test point matrix 8–13
8.8 Ventilator switch-over operating voltages 8–14
8.8.1 AC power supply operation 8–14
8.8.2 External battery operation 8–14
8.8.3 Internal battery operation 8–14
8.8.4 Measuring the voltages 8–14
8.9 Checking the internal battery 8–15
8.10 Checking the external battery 8–15
8.11 Replacing the alarm battery BT1 8–16
8.12 Replacing the clock battery 8–17
8.13 Setting the date and time 8–17
8.14 Erasing the calendar memory 8–17
8.15 Electrical safety precautions 8–17
8.15.1 Supply voltage 8–18
8.15.2 Insulation 8–18
8.15.3 Leakage currents 8–18
8.15.4 Leakage currents from the casing 8–18
8.15.5 Patient leakage currents 8–18
8.15.6 Leakage currents with mains power supply at the patient-connected part 8–18
8.16 Circuit diagrams 8–19
8.16.1 Circuit diagram – Alarm board, rev 4 8–20

8.16.2 Circuit diagram – Alarm board, rev 5 ... 8–21
8.16.3 Circuit diagrams (5) – CPU board, rev 5D ... 8–22
8.16.4 Circuit diagrams (5) – CPU board, rev 6E ... 8–27
8.16.5 Circuit diagrams (5) – CPU board, rev 7D ... 8–32
8.16.6 Circuit diagram – I/O board, rev A, art no 001905 ... 8–37
8.16.7 Circuit diagram – I/O board, rev 2, art no 002430 ... 8–38
8.16.8 Circuit diagram – PGC board, rev 4C ... 8–39
8.16.9 Circuit diagram – PGC board, rev 6B ... 8–40
8.16.10 Circuit diagram – Push-button membrane panel ... 8–41
8.17 Component location drawings ... 8–42
8.17.1 Component location drawing – Alarm board, rev 4 ... 8–43
8.17.2 Component location drawing – Alarm board, rev 5 ... 8–44
8.17.3 Component location drawing – CPU board, rev 4 ... 8–45
8.17.4 Component location drawing – CPU board, rev 5C ... 8–46
8.17.5 Component location drawing – CPU board, rev 6B and C ... 8–47
8.17.6 Component location drawing – CPU board, rev 7B ... 8–48
8.17.7 Component location drawing – I/O board, rev A, art no 001905 ... 8–49
8.17.8 Component location drawing – I/O board, rev 2, art no 002430 ... 8–50
8.17.9 Component location drawing – PGC board, rev 4 ... 8–51
8.17.10 Component location drawing – PGC board, rev 6B ... 8–52
8.17.11 Component location drawing – Push-button membrane panel ... 8–53
8.18 Lists of components ... 8–54
8.18.1 List of components – Alarm board, rev 4 ... 8–54
8.18.2 List of components – Alarm board, rev 5 ... 8–56
8.18.3 List of components – CPU board, rev 5 ... 8–58
8.18.4 List of components – CPU board, rev 6 ... 8–63
8.18.5 List of components – CPU board, rev 7B ... 8–68
8.18.6 List of components – I/O board, rev A ... 8–73
8.18.7 List of components – I/O board, rev 2 ... 8–74
8.18.8 List of components – PGC board, rev 4 ... 8–75
8.18.9 List of components – PGC board, rev 6B ... 8–77
8.18.10 List of components – Push-button membrane panel ... 8–79
8.18.11 List of components – Rear panel ... 8–80
8.18.12 List of components – Cables ... 8–81

9 Fault tracing ... 9–1

9.1 Fault tracing table ... 9–1
9.2 Error codes ... 9–2
9.2.1 Reading the error codes ... 9–2
9.2.2 Error code table ... 9–3

10 Appendices ... 10–1

10.1 Engineering change history ... 10–2
10.2 Service record – BREAS PV 403 ventilator ... 10–3
10.3 Returning products to BREAS ... 10–5

10.4 Delivery report – BREAS PV 403 ventilator 10–7

11 PV 403 SIMV Operating Manual

12 PV 403 PEEP Operating Manual

1 Introduction

This chapter gives an overview of the PV 403 ventilator and the service manual.

WARNING!

This product must be:

- **subjected to regular service, maintenance and control and any applicable upgrades, in accordance with BREAS service instructions.**
- **repaired and/or modified in accordance with BREAS service manuals, technical bulletins, and any special service instructions, by service technicians that have been authorised after BREAS PV 403 service training, or have an equivalent technical knowledge on medical respiratory devices.**

Deviation from these service instructions may lead to risk of personal injury!

1.1 About the PV 403 ventilator

1.1.1 Function

The PV 403 is a pressure-controlled, pressure-support, and volume-controlled ventilator for patients who require continuous or intermittent support by mechanical ventilation.

It has three modes of operation: PSV, PCV, and VCV. All modes have an adjustable trigger sensitivity setting which allows the patient to initiate ventilator-assisted breaths.

In the PCV mode (Pressure Controlled Ventilation), the ventilator provides assisted or controlled pressure-regulated breathing.

In the PSV mode (Pressure Support Ventilation), the ventilator's expiratory sense can also be adjusted allowing the ventilator to more easily match each patient's needs.

In the VCV mode (Volume Controlled Ventilation), the ventilator provides assisted or controlled volume-regulated breathing.

As an option, the PV 403 can be delivered with an internal PEEP (Positive End Expiratory Pressure) function, which is used for controlling the patient's airway pressure during the exhalation phase.

The internal patient data memory of the PV 403 can be downloaded to a PC, printed out, and analysed via the Calendar Data Analysis software package. For more information about this software package, please contact your BREAS representative.

For PV 403 SIMV only:
By combining one of these modes with the SIMV mode (Synchronized Intermittent Mandatory Ventilation) the PV 403 allows spontaneous breaths between the mandatory breaths that are assisted or controlled by the ventilator.

1.1.2 Intended use

The PV 403 is intended for treatment:

- in institutions and patients' homes,
- by qualified, trained personnel under the direction of a physician,
- of adult and pediatric patients with reduced lung function, using either a nasal mask or a trach tube,
- that may be life-supporting, provided that an internal or external battery back-up source is used and emergency equipment (resuscitation bag) is available.

1.1.3 Construction

The PV 403 is constructed around a bellows that is driven by a ball-screw assembly.

An electronically controlled servomotor rotates the ball screw via a belt transmission, thus moving the bellows up or down. A microprocessor controls the correct speed of the motor and its power supply by means of calculations based on the settings for pressure, rate, inspiration time, etc. The pressure and trigger settings are monitored at the same time.

1.1.4 Power failure alarm

In the event of a mains power failure, the ventilator will automatically switch to the external battery supply (if installed). Should this not be available, it will switch to the internal battery supply (if installed). The current power source is indicated in the LCD display of the ventilator. If the external or internal battery voltage drops too low, an audible alarm sounds.

1.1.5 Calendar Data Analysis software

The internal patient data memory of the PV 403 can be downloaded to a PC, printed out, and analysed via the Calendar Data Analysis software package, if installed on a PC. For more information about this software package, please contact your BREAS representative.

1.1.6 Service personnel's training requirements

Service personnel working with the PV 403 and PV 403 PEEP should have medical/ technical training and a good knowledge of the construction and function of respiratory devices. Authorisation by BREAS PV 403 service training is recommended.

Always contact your BREAS representative if you have any questions or if any training is required.

1.2 About this manual

1.2.1 Scope

This manual describes all the routine maintenance checks and the additional service actions for the PV 403 and the PV 403 PEEP. The manual contains all the documentation that is required for the maintenance and the service of the ventilator, such as replacement parts lists, exploded drawings, wiring diagrams, component location guides, etc.

BREAS Medical reserves the right to make changes to the products and/or the contents of this manual without any prior notice.

1.2.2 Intended audience

This service manual is intended for service technicians who have medical/technical training and who have a good knowledge of the construction and function of respiratory devices.

The service manual is NOT intended for clinical personnel or patients, who will find all the information they need in the PV 403 Operating Manual.

1.2.3 Icons

In this manual, icons are used to highlight specific information. The meaning of each icon is explained in the table below.

ICON	EXPLANATION
	Warning! Risk of death and serious personal injury.
	Caution! • Risk of minor or moderate injury. • Risk of equipment damage, loss of data, extra work, or unexpected results.
	Note Information that may be valuable but is not of critical importance, tips.
	Reference Reference to other manuals with additional information on a specific topic.

2 Maintenance instructions

This chapter describes all the routine maintenance checks and additional service instructions for the PV 403.

WARNING!

This product must be:

- **subjected to regular service, maintenance and control and any applicable upgrades, in accordance with BREAS service instructions.**
- **repaired and/or modified in accordance with BREAS service manuals, technical bulletins, and any special service instructions, by service technicians that have been authorised after BREAS PV 403 service training, or have an equivalent technical knowledge on medical respiratory devices.**

Deviation from these service instructions may lead to risk of personal injury!

For information about pressure calibration, fault-tracing, detailed drawings, board schematics, replacement parts, and so on, refer to the respective chapter in this service manual.

The patient and/or care providers should follow the checks that are described in the PV 403 Operating Manual.

2.1 Purpose

The PV 403 is designed to give users many years of trouble-free breathing assistance, provided that the preventive maintenance is carried out at the intervals specified in this manual. The service intervals vary depending on the type of operation for which the ventilator is used.

Well-performed maintenance services will considerably increase the life of the ventilator.

It is also important that any peripheral equipment is checked at the same time as services are carried out.

2.2 Introduction

Before you start a maintenance service, read the safety precautions and make sure you have a new service record and all the necessary equipment, tools, and replacement parts at hand.

2.2.1 Service schedule

The maintenance service includes all the checks listed in the schedule below.

A complete maintenance service (as described in this chapter) must be carried out at least every 12 months. If the ventilator is used for continuous operation (24 hours a day), a complete maintenance service must be carried out every 6 months.

Interval	Service check	See section
Every 12 months, or every 6 months if the ventilator is used for continuous operation (24 hours a day).	**Motor assembly**	
	Replace the drive belt.	6.3
	Lubricate the ball screw.	6.4
	Replace the check valve membranes and the O-rings.	6.5
	Test for leakage from the motor assembly and the tubes.	6.6
	Electronics	
	Calibrate the pressure sensors.	7.3.4
	Check the internal battery operation (where applicable).	8.9
	Check the external battery operation (where applicable).	8.10
	Check the electrical safety levels.	8.15
	Accessories (where applicable)	
	Inspect the patient circuit.	2.6.11
	Change the membrane in the exhalation valve.	2.6.12
	Clean the PEEP adapter, change the O-ring.	2.6.13
Every 24 months	Replace the internal battery kit.	5.5
Every 5 years	Change the alarm battery and the clock battery.	8.11, 8.12
Every 20,000 operating hours	Change the complete motor assembly.	5.11, 5.12
	Change the PEEP compressor (only applicable for PV 403 PEEP).	5.7

2.2.2 Safety precautions

Follow the safety precautions below when working with the PV 403:

- Do not work on the ventilator with the casing removed and the power supply connected, unless the instructions in this manual clearly says so.
- Always use caution when working with the ventilator connected to the mains and the casing removed.
- Do not use explosive gases and/or fluids near the ventilator.
- Make sure that all precautions to prevent electrostatic discharge (ESD) have been taken. Follow all regulations regarding ESD.

The PV 403 Operating Manual contains an extended list of safety precautions.

2.2.3 Service record

The BREAS service record is in chapter 10 “Appendices”, section 10.2.

- Copy the service record and use it for noting the service checks while performing the yearly service.

2.2.4 Inspection equipment and tools

Before starting the service of the PV 403, make sure you have the following equipment at hand:

- Test lung or reservoir bag, for example, BREAS part no. 001917.
- Measuring instrument for tidal volume and minute volume/rate (Biotek ventilator tester, Timeter, spirometer, or equivalent).
- Pressure manometer, for example, Thommen HM 28 digital manometer, part no. 001934.
- Digital voltmeter.
- Standard toolkit containing screwdrivers, Allen keys, Torx keys, and sockets.
- BREAS computer cable with 25-pin connector to the PV 403, part no. 001980.
- Installation CD for PV 403 pressure calibration software, part no. 001703

2.2.5 Replacement parts

The following replacement parts should be available when servicing the ventilator:

Description	Part no.
Patient circuit	000402
Service kit incl. membranes, O-rings for check valves, and drive belt	001509
Membrane assembly for exhalation valve	000518
Grease (BREAS 283 AZ)	000557
Air filter, patient air, washable	001445
Air filter, patient air, disposable	001428

Description	Part no.
If required:	
Internal battery kit	002020
Battery NiMH 4.8 V, 70 mAh	000568
Battery CR 2032	002129
Motor assembly kit for replacement after 20,000 operating hours	000549
PEEP compressor assembly for replacement after 20,000 operating hours	003235

2.3 Preparing for inspection

2.3.1 Verifying the components and the installed software

- Check the engineering change history in chapter 10 “Appendices” to find out what changes have been made to the ventilator, and from which serial number they were implemented.

If in any doubt, check the component designations on the circuit boards – upgrades may have been made that have not been recorded in the engineering change history.

2.3.2 Initial recording

1. Copy a new service record (see chapter 10 “Appendices”).
2. Identify the PV 403.
3. Note the model and serial number and any inventory number on the service record.
4. Check any comments recorded on previous service records.
5. Document the current patient settings.

2.3.3 Checking additional services

1. Note the number of operating hours on the service record.
2. Check the service schedule to see whether the alarm batteries, the internal battery kit, or the complete motor assembly need to be replaced.

2.3.4 Inspecting the markings

Make sure that all markings on the ventilator’s information labels can be read:

- Make, model description, serial number
- Warning texts
- Any inventory marking
- Any other texts

2.3.5 Information from the patient/user

Check the following with the patient:

- Has the ventilator functioned without any problems? If not, what were they?
- How does the patient/care provider check the function of the ventilator? How often?
- How often is the filter replaced?
- How many filters will be required before the next service?
- Other observations?

2.3.6 Validity of the documentation

1. Check the validity of the Operating Manual.
2. Check if any modification or upgrading of the ventilator needs to be done at the same time as the service.

2.4 External inspection

2.4.1 Visual inspection for external damage and wear

1. Clean the outside of the ventilator using window-cleaning fluid or equivalent.
2. Check for any visible damage to the casing and the other components.
3. Check that nothing has become loose (including the handle).

2.4.2 Checking the power connection

1. Check the plugs on the power cord, the cord itself, and the ventilator's power socket.
2. Make sure that the strain-relief clamp for the power cord is not damaged.
3. Inspect the external battery cable, if used.
4. Check the external battery socket in the ventilator.

2.4.3 Minimum function check

1. Connect the power cord.
2. Connect the patient circuit.
3. Switch on the ventilator and make sure it operates normally.

2.5 Internal inspection

Make sure to disconnect the power supply before removing the casing of the ventilator.

2.5.1 Cleaning the inside of the ventilator

1. Remove the casing. See chapter 5 “Removing and replacing the main components” for instructions.
2. Remove any dirt or dust that has collected in the ventilator.

2.5.2 Checking the cables

1. Inspect all the cables and their connectors. Check the front and rear panels to make sure that the cables and the wires are not pinched.
2. Change any cable strap anchor that has become loose.

2.5.3 Checking the fastening of components

- Make sure that all the components, such as the motor, the circuit boards, the connectors, and so on, are securely fastened.

2.5.4 Replacing the drive belt

- Refer to section 6.3 for information.

2.5.5 Lubricating the ball screw

- Refer to section 6.4 for information.

2.5.6 Replacing the membrane assemblies in the check valves

- Refer to section 6.5 for information.

2.5.7 Checking the power supply

1. Make sure that the power socket is undamaged and that it is securely in place.
2. Check the wiring to and from the CPU board.

2.5.8 Calibrating the pressure sensors

- Refer to chapter 7.3.4 “Verifying the calibration of the pressure sensors” for information.

2.5.9 Reassembling the casing

- Refer to chapter 5 “Removing and replacing the main components” for instructions.

2.5.10 Electrical safety

- Refer to section 8.15 for information.

2.5.11 Testing for leakage of the tubes and bellows

- Refer to section 6.6 for information.

2.6 Final inspection

2.6.1 Function check

- Connect the patient circuit, start the ventilator, and check that everything works normally.

2.6.2 Checking the leakage alarm for low pressure

1. Set the pressure to 20 mbar.
2. Create a leak so that a pressure of 20 mbar cannot be reached.
3. Check that the Pressure alarm LED is lit and that an audible alarm sounds.

2.6.3 Checking the low-volume alarm

1. Set the low-volume limit to a value that is higher than the volume of the test lung/ reservoir bag.
2. Check that the Volume alarm LED is lit and that an audible alarm sounds.

2.6.4 Checking the alarm mute

1. Switch on the ventilator. Do not connect anything to the patient air connection. Wait for 15 seconds until the volume alarm is activated.
2. Press the Mute button and make sure the signal is muted. Make sure the signal starts again after approximately 2 minutes.

2.6.5 Checking the trigger

1. Set the trigger to –0.5 mbar.
2. Create a negative pressure and make sure a triggered breath is given. The green Insp. Trig. LED should be lit.

2.6.6 Checking the pressure/rate

1. Adjust the settings as follows:

Pressure	20 mbar
Rate	10 BPM
Insp. time	3.0 seconds
Mode	PCV

2 Measure and check that the pressure, rate, and inspiration time are correct (accuracy ±10%). The measuring should be done with a test lung or a reservoir bag connected (if these are not available, block the exhalation valve in the patient circuit).

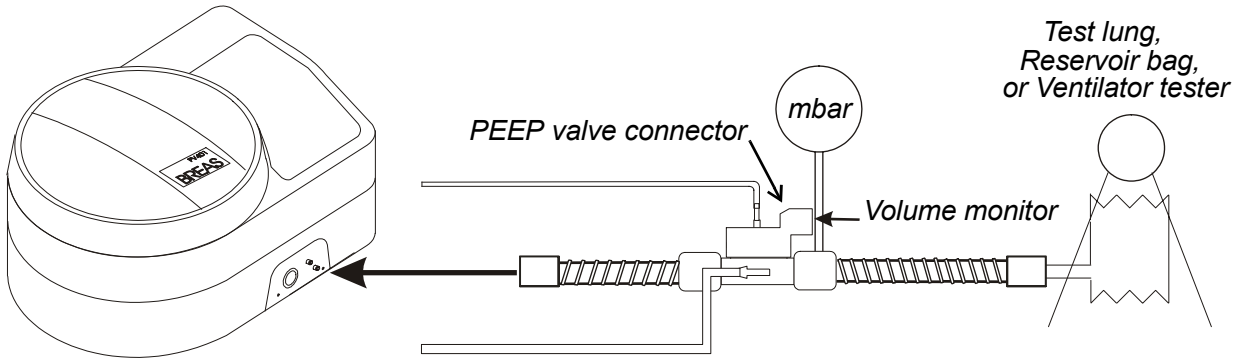


Fig. 2-a Checking the pressure and the rate

2.6.7 Checking the tidal volume indication

If you use a Biotek VT-1 or 2 ventilator tester, you can test the estimated tidal volume as follows:

1 Set the compliance of the test lung to 0.02 l/mbar.

2 Select volume measuring.

3 Set the PV 403 as follows:

Pressure	30 mbar
Rate	8 BPM
Insp. time	5.0 seconds
Mode	PCV

4 Check the accuracy (±20%).

If you check the tidal volume using a volume monitor, you need an exhalation valve with a PEEP valve connector. Connect the volume monitor to the PEEP valve outlet on the exhalation valve outlet.

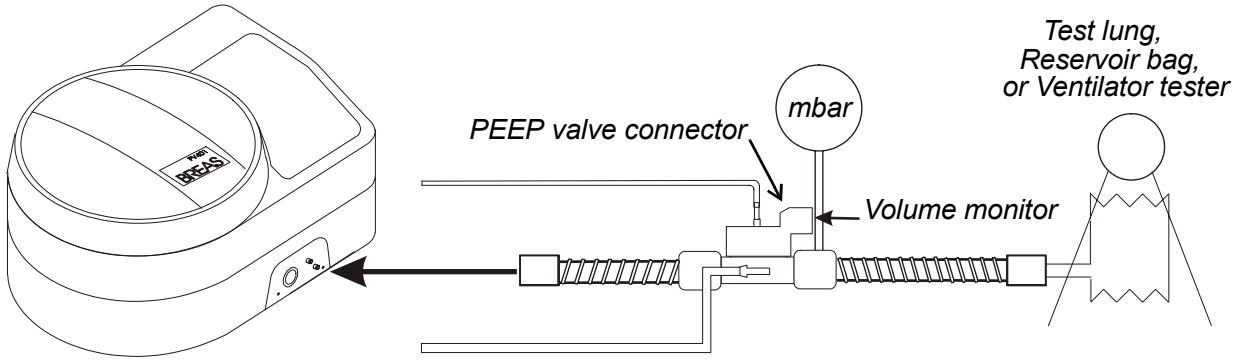


Fig. 2-b Checking the tidal volume

2.6.8 Checking the tidal volume (VCV mode)

This procedure is used for checking the tidal volume delivered in VCV mode.

1. Set the compliance of the test lung to 0.05 l/mbar.
2. Set the PV 403 as follows:

Tidal volume	0.8 l
Rate	8 BPM
Insp. time	2.0 seconds
Mode	VCV

3. Check that the measured volume is 0.8 l (accuracy ±10%).

2.6.9 Checking external battery operation

1. Connect an external battery to the ventilator.
2. Disconnect the power cord while the ventilator is running.
3. Check that the ventilator automatically switches over to external battery operation. The following should occur:
   – an audible alarm sounds (not if an internal battery is installed)
   – the On/Off button LED starts flashing
   – the letter **E** is displayed in the Power field
4. Reconnect the power cord and check that:
   – the audible alarm stops
   – the On/Off button LED shows a steady light
   – the letter **M** is displayed in the Power field

2.6.10 Checking internal battery operation

1. Disconnect any external battery from the ventilator.
2. Disconnect the power cord while the ventilator is running.
3. Check that the ventilator automatically switches over to internal battery operation. The following should occur:
   – an audible alarm sounds
   – the On/Off button LED start flashing
   – the letter **I** is displayed in the Power field
4. Reconnect the power cord and check that:
   – the audible alarm stops
   – the On/Off button LED shows a steady light
   – the letter **M** is displayed in the Power field

2.6.11 Inspecting the patient circuit

- Inspect the patient circuit and replace it if necessary.

2.6.12 Replacing the membrane assembly in the exhalation valve

1 Unscrew the complete membrane assembly.

2 Clean the inside of the exhalation valve using a damp cloth (clean the valve in accordance with any local regulations).

3 Carefully fit the new membrane assembly. Make sure that it seats properly in the groove.

4 Connect the exhalation valve to a test lung. Check that no leakage occurs during the exhalation phase.

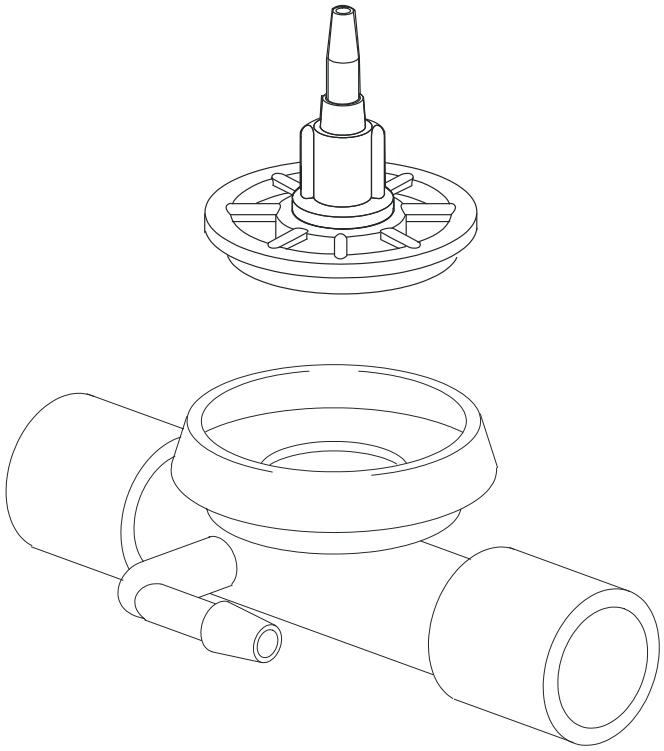
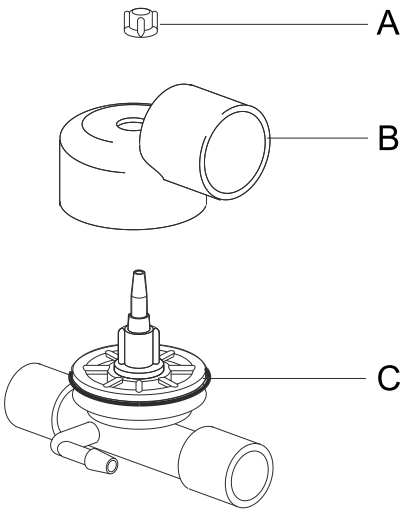


Fig. 2-c BREAS exhalation valve

2.6.13 Cleaning the PEEP valve adapter

The PEEP valve adapter should be cleaned in accordance with the clinic's instructions.

To clean the PEEP valve adapter:



1 Remove the plastic nut (A) holding the PEEP valve adapter.

2 Pull the PEEP valve adapter (B) up from the exhalation valve.

3 Clean the adapter using a damp cloth.

– If the adapter need to be disinfected, this can be done in a bath of Virkon® or Lysetol® Med, for instance. Then rinse the parts well in clear water and dry them thoroughly.

– The adapter can be autoclaved at 126 °C for 15 min. This treatment can be repeated up to 20 times.

4 Before fitting the adapter cover, remove the old O-ring (C) from the exhalation valve, and fit a new O-ring as shown in the figure below.

5 Fit the PEEP valve adapter to the exhalation valve and screw on the plastic nut.

Do not fit the O-ring to the exhalation valve cover before screwing it on (see figure below).

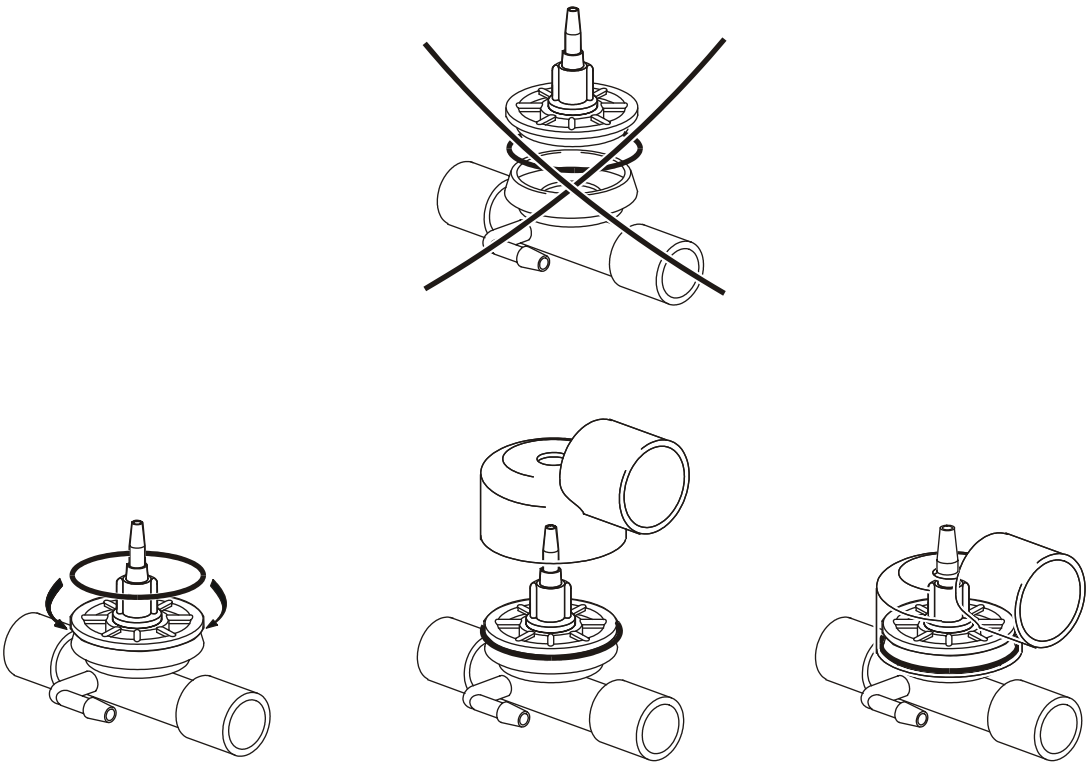


Fig. 2-d Fitting the O-ring to the exhalation valve

2.6.14 Inspecting the ventilator accessories

- Check any other accessories that are used with the ventilator.

2.6.15 Changing/washing the patient filters

1. Change the white air filter. Make sure the patient has enough filters to last until the next service.
2. Wash or change the grey filter, if necessary.

2.6.16 Adjusting the settings for the patient

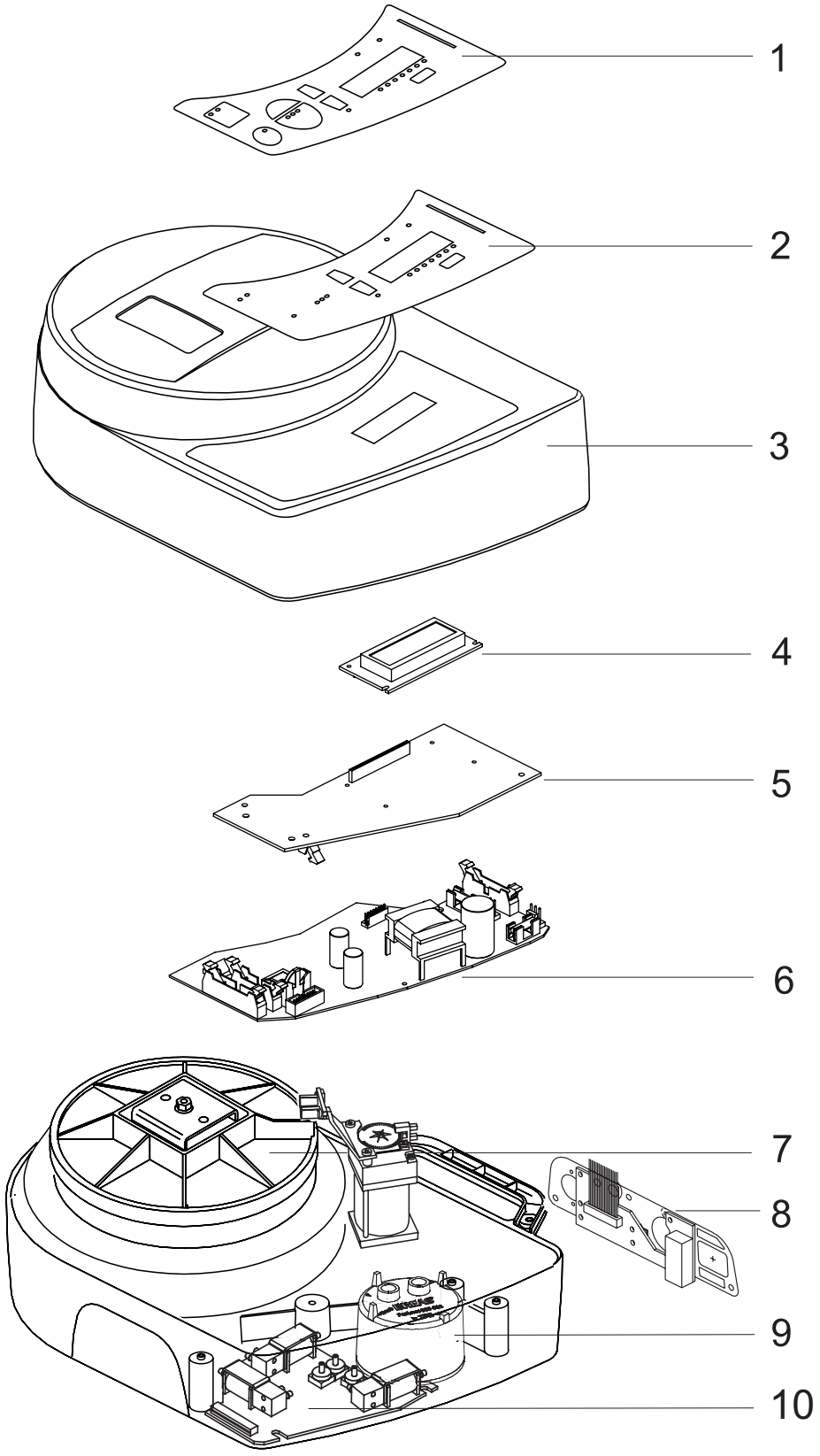
- Adjust the settings as prescribed for the patient.

3 Parts location

This chapter contains part-number lists and drawings of the parts for the ventilator.

3.1 Parts drawing 1 – Main components

The figure below shows the main components of the PV 403

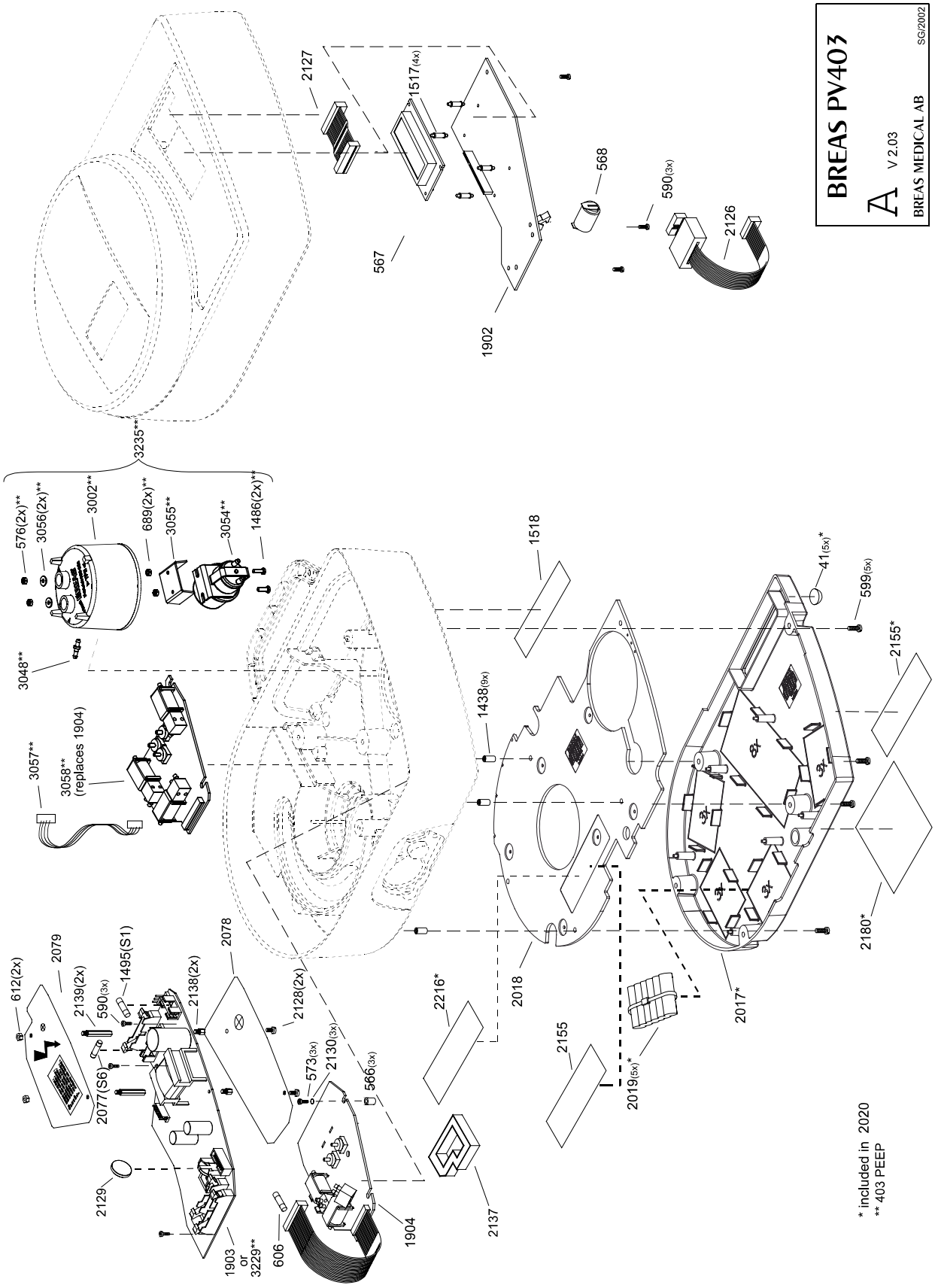


The table below lists the main components of the ventilator.

No.	Description
1	Panel label
2	Membrane push-button pad
3	Upper casing
4	LCD display
5	Alarm board
6	CPU board
7	Motor assembly, complete
8	I/O (Input/Output) board
9	PEEP compressor (only in PV 403 PEEP)
10	PGC (Pressure Gauge Card) board

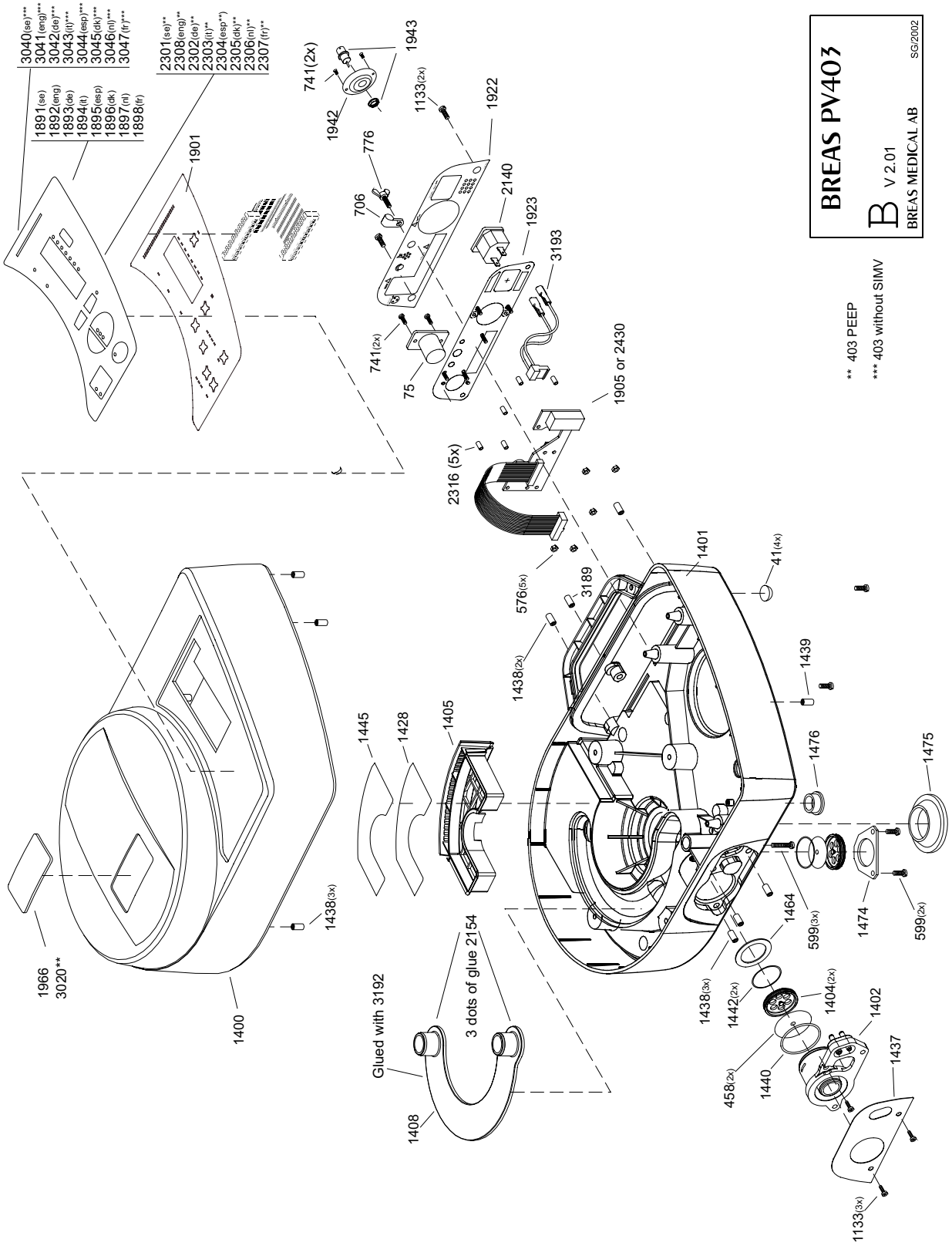
3.2 Parts drawing 2 – Motor, circuit boards, and transformer

For definitions of the part numbers, refer to the parts list in section 3.6.



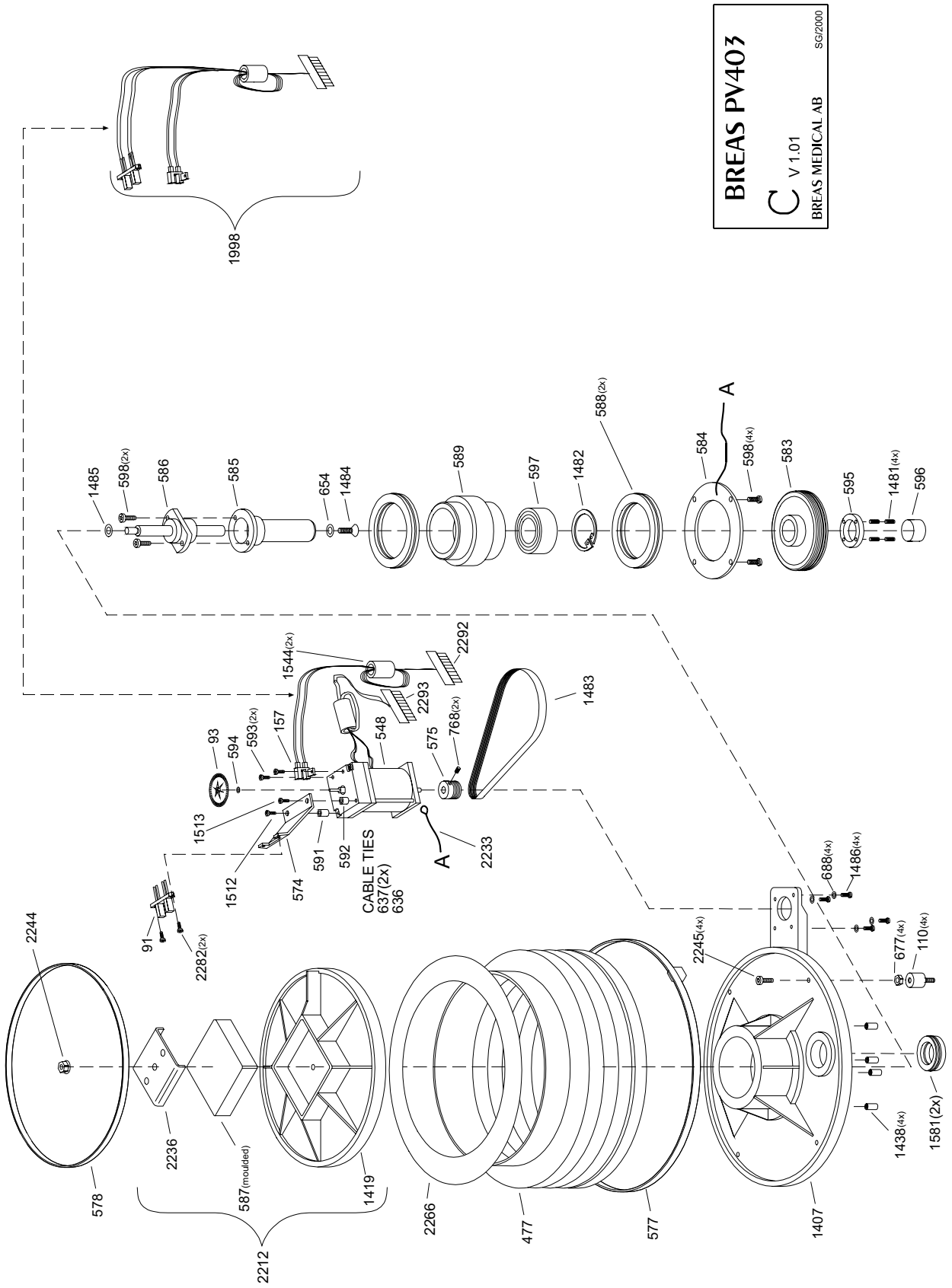
3.3 Parts drawing 3 – Casings, panels, labels, valves, filters

For definitions of the part numbers, refer to the parts list in section 3.6.



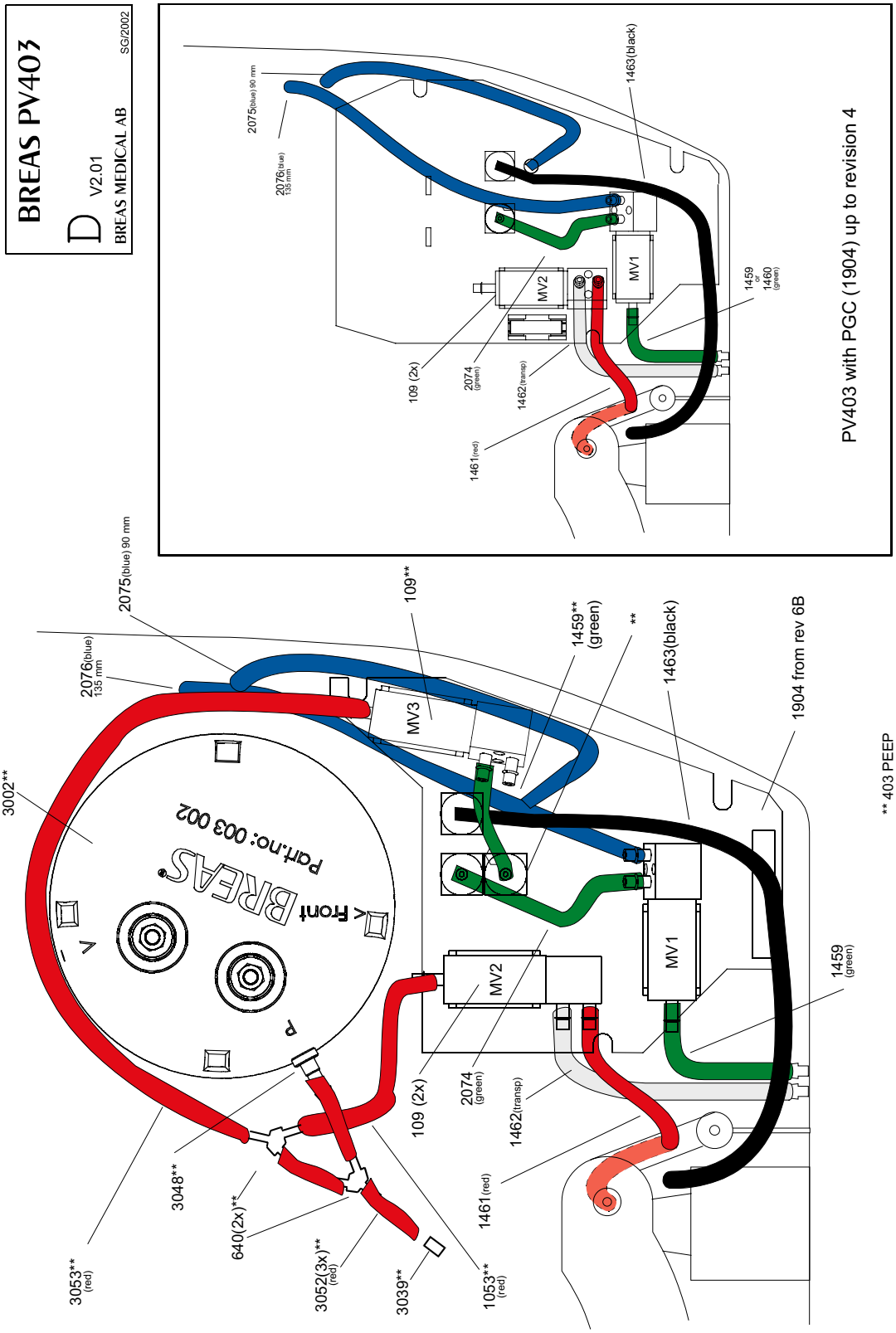
3.4 Parts drawing 4 – Motor assembly

For definitions of the part numbers, refer to the parts list in section 3.6.



3.5 Parts drawing 5 – Tubes and connections

For definitions of the part numbers, refer to the parts list in section 3.6.



3.6 Parts list for PV 403 and PV 403 PEEP

The parts of the PV 403 and PV 403 PEEP are listed in the table below.

Part no.	Definition
000015	Grease, 283 AC, 10 g
000041	Rubber feet
000075	Chassis pin device
000091	Optoswitch, home position
000093	Encoder disc
000109	Magnetic valve
000110	Vibrator isolator – cylindrical, 15 × 15 mm
000157	Optoswitch
000259	Ventilator trolley
000402	Patient circuit
000458	Membrane, check valve
000477	Bellows
000518	Membrane assembly for exhalation valve
000548	Motor
000549	Motor assembly, complete
000557	Grease, 283 AZ
000563	Motor assembly, exchange assembly
000566	Tube 2.5 × 6 Blue 6 mm length
000567	Display LCD (powertip) for PV 403 with soldered-on pin strip
000568	Battery NiMH 4.8 V, 70 mAh
000569	Battery for internal memory, lithium 3 V, 70 mAh, l 25 mm, diam 17 mm
000570	Ribbon cable, 40-pole with IDC l = 100 mm (CPU overlay)
000573	Screw RTX FXST 2.9 × 16 Fzb
000574	Fastening bracket for optoswitch
000575	Pulley wheel motor poly-V
000576	Nut M3 Nyloc
000577	Bellows clamp, steel 325 mm PV 403 lower
000578	Bellows clamp, steel 215 mm PV 403 upper
000581	Sealing ring, air tube, white silicon
000582	Fastening plate for moving bellows end cover
000583	Pulley wheel large poly-V

Part no.	Definition
000584	Flange
000585	Shaft
000586	Ball screw with nut
000587	Polyurethane elastomer (Swedac U-16 soft end cover)
000588	Sealing ring, bearing, white silicon
000589	Bearing sleeve
000590	Screw RTK 2.9 × 9.5 Fzb
000591	Spacer piece DRM 4380 × 12
000592	Spacer piece DRM 4380 × 10
000593	Screw MRT 3 × 8 Fzb
000594	Washer 2.7 × 6 × 0.5 DIN 125
000595	Cover nut
000596	Threaded cover
000597	Ball bearing, twin race angled contact bearing
000598	Screw MRT 4 × 10 Fzb
000599	Screw MRT 4 × 10 black-chromate
000606	Fuse, F 3, 15 A
000612	Nut with lock washer M3 Fzb BN 1364
000636	Cable strap 8"
000637	Cable strap 4"
000640	Y-connector
000654	Washer – M6, flat washer BRB 6.4 Fzb
000677	Nut – M6M steel M4 NV7 × 3.2 Fzb
000688	Washer – M3, flat washer BRB 3.2 × 6 × 0.5 Fzb
000689	M3-nut
000706	Strain relief for cable, mains
000768	Stop screw M3 × 5
000776	Screw – VS steel M4 × 12 Fzb
000784	Grease, 283 AZ
000813	Box (510 × 390 × 290)
001053	Silicon tube, 30 mm (red)
001133	Screw MRT 4 × 14 black-chromate
001400	Casing upper

Part no.	Definition
001401	Casing lower
001402	Outlet patient air
001403	Cover (over filter cassette)
001404	Valve – back seat
001405	Filter cassette
001407	Fixed end PV 403
001408	Cover (air channel)
001409	Bellows PV 403
001419	Moving bellows end cover mould-injected
001428	Filter, washable
001437	Label – patient air outlet
001438	Screw – M4 insert threaded Spreadsert 1
001439	Screw – M5 insert threaded Spreadsert 1
001440	O-ring 37.0 × 2.0 EPDM
001442	O-ring 28.0 × 1.3 EPDM
001445	Filter – coarse, disposable
001458	Tube blue 2.5 × 6 125 mm silicon
001459	Tube green 2.5 × 6 45 mm silicon
001460	Tube green 2.5 × 6 45 mm silicon
001461	Tube red 2.5 × 6 100 mm silicon
001462	Tube neutral 2.5 × 6 65 mm silicon
001463	Tube black 2.5 × 6 230 mm silicon
001464	Seal silicon 35.5 × 25 × 1.0
001474	Lock washer for check valve PV 403
001475	Bottom plug
001476	Protective plug for internal battery connector
001477	D-sub protection for female 25-pole
001480	Nut flange nut DIN 6923 M5
001481	Stop screw P655 4 × 5 Fzb
001482	Groove ring SgH 47 seeger fuse “dp 403”
001483	Poly V-belt 4-170H
001484	Screw MF6S 4 × 8 Fzb
001485	Washer

Part no.	Definition
001486	Screw MRT 3 × 10 Fzb
001495	Fuse T 1A (5 × 20)
001509	Service kit incl. membranes, O-rings for check valves, and drive belt
001511	Screw M4 insert thread non-locking for wing bolt in rear panel
001512	Screw 30 mm 5/32"
001513	Screw 15 mm 5/32"
001517	Spacer 9.93 mm miniature distance bushing CBSTE-6-01A-RT
001518	Label serial number
001541	Label with instructions för internal battery pack PV 403
001544	Ferrite clamp on motor and sensor cables
001634	Optoswitch cable, complete
001723	Box, half
001886	Cable 25M-25 D-SUB 10 m
001891	Overlay – push-button/LCD PV 403 SIMV, Swedish
001892	Overlay – push-button/LCD PV 403 SIMV, English
001893	Overlay – push-button/LCD PV 403 SIMV, German
001894	Overlay – push-button/LCD PV 403 SIMV, Italian
001895	Overlay – push-button/LCD PV 403 SIMV, Spanish
001896	Overlay – push-button/LCD PV 403 SIMV, Danish
001897	Overlay – push-button/LCD PV 403 SIMV, Dutch
001898	Overlay – push-button/LCD PV 403 SIMV, French
001901	Membrane push-button panel
001902	Alarm circuit board PV 403
001903	CPU/Motor circuit board PV 403
001904	PGC circuit board PV 403
001905	I/O circuit board PV 403
001922	Overlay rear panel
001923	Plate, rear panel
001966	Logo
001980	Cable, computer communication
001992	Filter disposable PV 403, 1 pc./package
001993	Filter disposable PV 403, 50 pcs/package
001998	Optoswitch cable, complete

Part no.	Definition
002003	Operating manual PV 403 SIMV Swedish
002004	Operating manual PV 403 SIMV Danish
002005	Operating manual PV 403 SIMV Norwegian
002006	Operating manual PV 403 SIMV Finnish
002007	Operating manual PV 403 SIMV English
002008	Operating manual PV 403 SIMV German
002009	Operating manual PV 403 SIMV French
002010	Operating manual PV 403 SIMV Dutch
002011	Operating manual PV 403 SIMV Italian
002012	Operating manual PV 403 SIMV Spanish
002013	Operating manual PV 403 SIMV Greek
002014	Operating manual PV 403 SIMV Portuguese
002017	Internal battery casing
002018	Lid for internal battery casing
002019	Internal battery 20 pcs 4/3
002020	Internal battery kit (2017+2018+2019+41(4 pcs))
002074	Tube-green 2.5 × 6 60 mm silicon
002075	Tube-blue 2.5 × 6 90 mm silicon
002076	Tube-blue 2.5 × 6 135 mm silicon
002077	Fuse 5 × 20 mm Slow 5 A
002078	Circuit board (shield)
002079	Circuit board (touching protection)
002125	Fuse, picofuse 125 mA (solderable fuse CPU PV 403)
002126	Ribbon cable 16-pole, CPU – alarm
002127	Ribbon cable 26-pole, alarm – membrane push-button panel
002128	Screw M3 × 3 Torx
002129	Battery CR2032 3 V, 230 mAh, lithium
002130	Rubber feed through
002131	Service manual PV 403 English
002134	Fuse, picofuse 750 mA (solderable fuse CPU PV 403)
002135	Absorbent 133 × 65 × 3
002136	Absorbent 48 × 65 × 3
002137	Absorbent (between PGC board and lower casing) + adhesive

Part no.	Definition
002138	Screw – distance – DSS M3050 × 5 (circuit board, shield)
002139	Screw – distance – DSS M3050 × 5 (circuit board, touching protection)
002140	Mains inlet connector, class 2
002141	Cable strap 6" (150 mm)
002142	Ferrite clamp for alarm board/ribbon cable
002144	Operating manual PV 403 SIMV Polish
002154	ABS glue, grey (special)
002155	Label, technical information PV 403
002180	Label, internal battery charging information
002212	Moving bellows end, complete (2236 + 587 + 1419)
002216	Label, part number internal battery PV 403
002224	M6M Nyloc M6
002233	Earth cable
002236	Fastening plate
002244	Nut M6M Nyloc M6DIN 985 low
002245	Screw MC6S M4 × 12 Fzb
002265	Screw 6-32 × 1 1/4
002266	Support ring
002282	Screw RTS 2.9 × 6.5 Fzb
002301	Overlay – push-button/LCD PV 403 PEEP, Swedish
002302	Overlay – push-button/LCD PV 403 PEEP, German
002303	Overlay – push-button/LCD PV 403 PEEP, Italian
002304	Overlay – push-button/LCD PV 403 PEEP, Spanish
002305	Overlay – push-button/LCD PV 403 PEEP, Danish
002306	Overlay – push-button/LCD PV 403 PEEP, Dutch
002307	Overlay – push-button/LCD PV 403 PEEP, French
002308	Overlay – push-button/LCD PV 403 PEEP, English
002316	Distance 7 mm
002335	Tube-black 2.5 x 6 245 mm silicone
002415	Filter reusable, 1 pc/pkg
002430	I/O printed circuit card PV 403
002707	Shims 37 x 47 x 0.2
003002	Compressor housing for PV 403 PEEP

Part no.	Definition
003020	Polygloss label logo PV 403 PEEP
003039	Throttling PV 403 PEEP
003040	Overlay – push-button/LCD PV 403 without SIMV, Swedish
003041	Overlay – push-button/LCD PV 403 without SIMV, English
003042	Overlay – push-button/LCD PV 403 without SIMV, German
003043	Overlay – push-button/LCD PV 403 without SIMV, Italian
003044	Overlay – push-button/LCD PV 403 without SIMV, Spanish
003045	Overlay – push-button/LCD PV 403 without SIMV, Danish
003046	Overlay – push-button/LCD PV 403 without SIMV, Dutch
003047	Overlay – push-button/LCD PV 403 without SIMV, French
003048	Nippel PV 403 PEEP
003052	Tube- red 2.5 x 6 20 mm silicone
003053	Tube- red 2.5 x 6 170 mm silicone
003054	Compressor
003055	Anchorplate for compressor
003056	Plate 3.2 x 9 x 0.8 mm Fzb
003057	Cable 4-pole between PGC & CPU
003058	Circuit board PGC PV 403 PEEP
003175	Operating manual PV 403 / PV 403 PEEP Swedish
003176	Operating manual PV 403 / PV 403 PEEP English
003177	Operating manual PV 403 / PV 403 PEEP Finnish
003178	Operating manual PV 403 / PV 403 PEEP Norwegian
003179	Operating manual PV 403 / PV 403 PEEP Spanish
003180	Operating manual PV 403 / PV 403 PEEP Italian
003181	Operating manual PV 403 / PV 403 PEEP Dutch
003182	Operating manual PV 403 / PV 403 PEEP Danish
003183	Operating manual PV 403 / PV 403 PEEP French
003184	Operating manual PV 403 / PV 403 PEEP German
003185	Operating manual PV 403 / PV 403 PEEP Greek
003186	Operating manual PV 403 / PV 403 PEEP Portuguese
003187	Operating manual PV 403 / PV 403 PEEP Polish
003229	CPU/Motor board PV 403 PEEP
003234	Casing lower, PV 403 / PV 403 PEEP

Part no.	Definition
003251	Screw RTK 2.9 x 9.5 Fzb
003257	Circuit board membrant./LED PV 403

4 Functional diagrams

This chapter contains a diagram of the pneumatic system of the ventilator and a block diagram of the PV 403's functions.

4.1 Functional block diagram PV 403

The functional block diagram below shows how the electronics are designed and how they are connected to the other components.

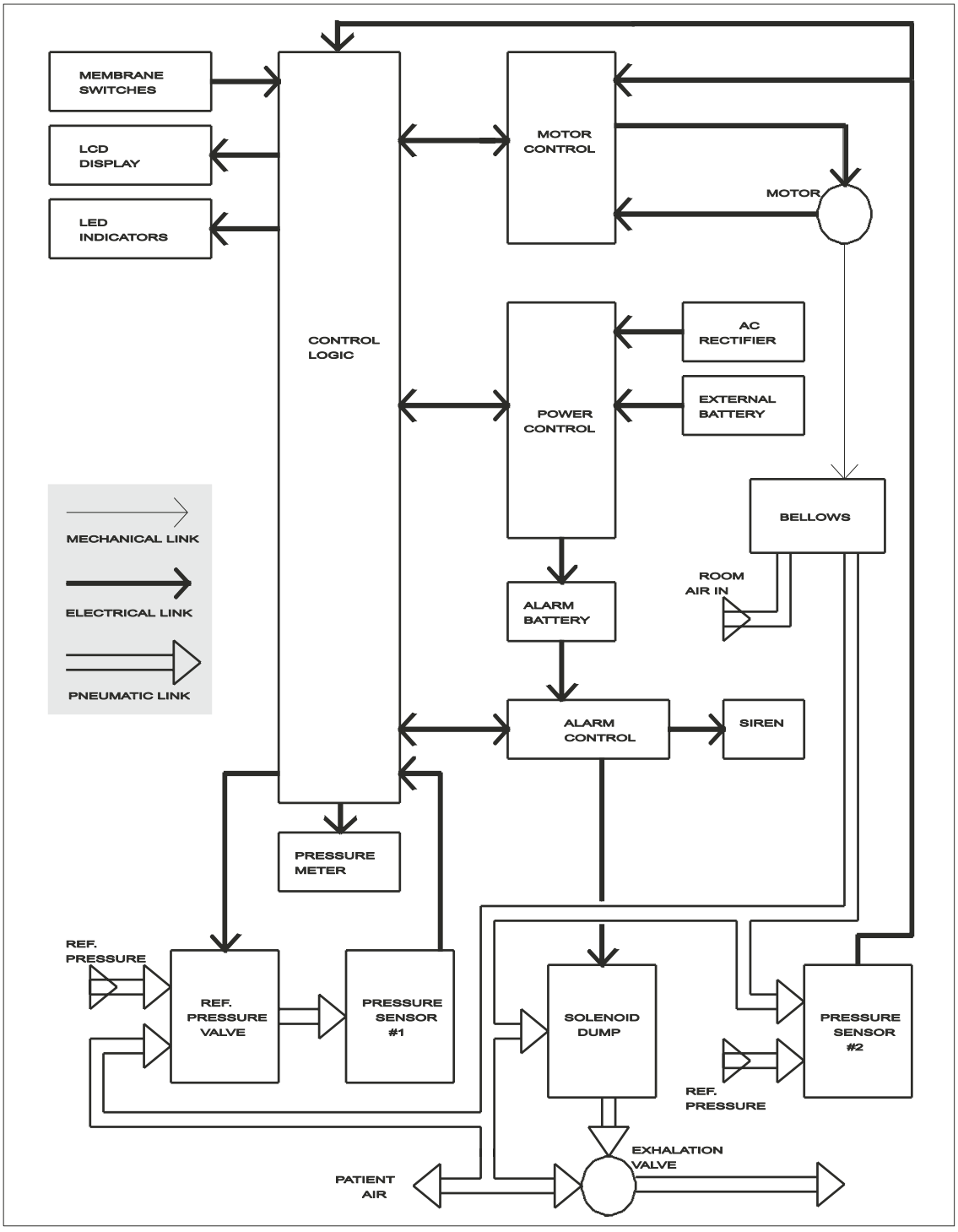


Fig. 4-a Functional block diagram PV 403

4.2 Functional block diagram PV 403 PEEP

The functional block diagram below shows how the electronics are designed and how they are connected to the other components.

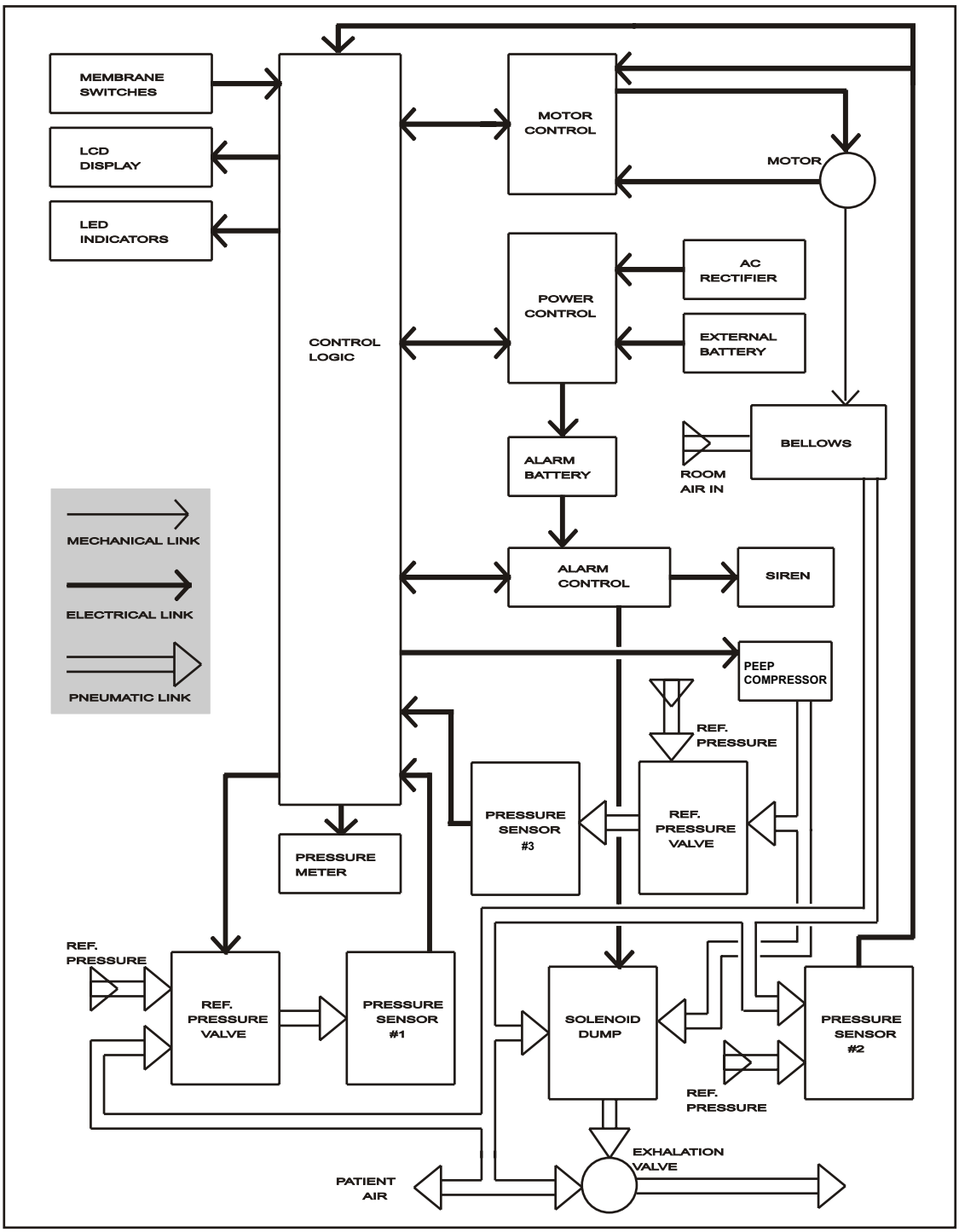


Fig. 4-b Functional block diagram PV 403 PEEP

4.3 Pneumatic diagram PV 403

The pneumatic diagram below shows the pneumatic components of the air circulation of the PV 403.

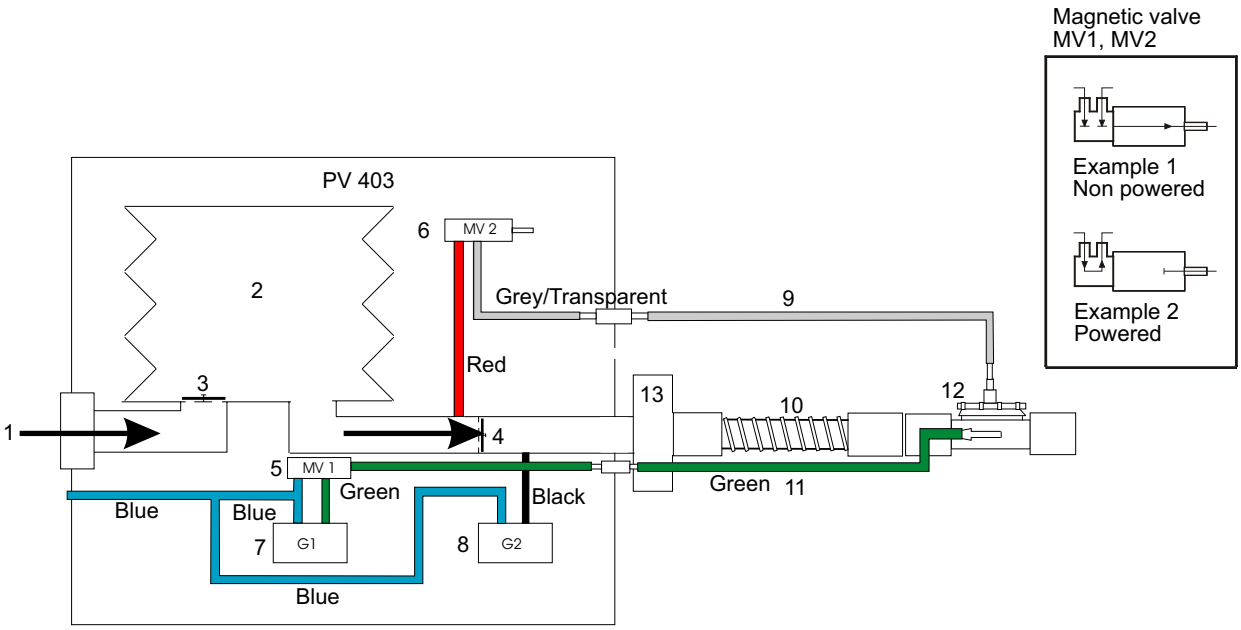


Fig. 4-c Pneumatic diagram PV 403

The table below describes the components of the pneumatic diagram.

No.	Component
1	Patient air inlet (through air filter)
2	Bellows
3	Check valve (closed during inspiration)
4	Check valve (closed during expiration)
5	Magnetic valve MV 1 (Normally set as in example 1. Switches off G1 during auto-calibration, as shown in example 2.)
6	Magnetic valve MV 2 (Normally set as in example 2. Safety valve operates when pressure is too high, as shown in example 2.)
7	Pressure sensor G1
8	Pressure sensor G2
9	Control pressure tube for the exhalation valve
10	Patient air tube
11	Tube for measuring the pressure
12	Exhalation valve
13	Bacteria filter (if used)

4.4 Pneumatic diagram PV 403 PEEP

The pneumatic diagram below shows the pneumatic components of the air circulation of the PV 403 PEEP.

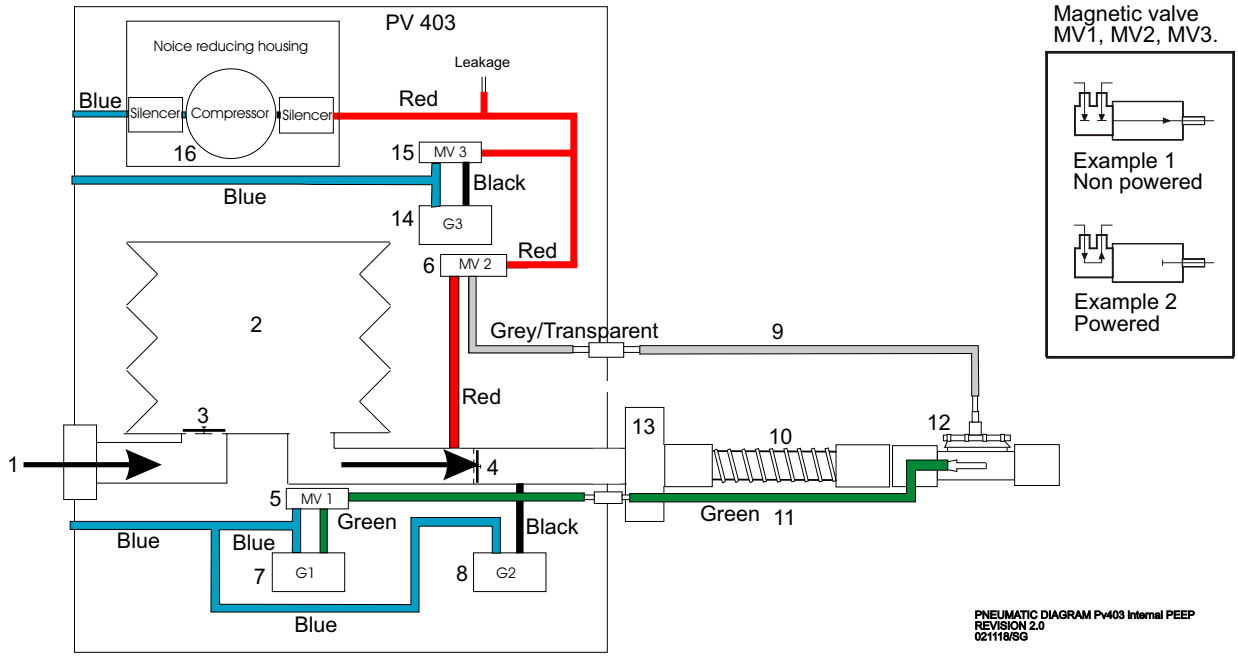


Fig. 4-d Pneumatic diagram PV 403 PEEP

The table below describes the components of the pneumatic diagram.

No.	Component
1	Patient air inlet (through air filter)
2	Bellows
3	Check valve (closed during inspiration)
4	Check valve (closed during expiration)
5	Magnetic valve MV 1 (Normally set as in example 1. Switches off G1 during auto-calibration, as shown in example 2.)
6	Magnetic valve MV 2 (Normally set as in example 2. Safety valve operates when pressure is too high, as shown in example 2.)
7	Pressure sensor G1
8	Pressure sensor G2
9	Control pressure tube for the exhalation valve
10	Patient air tube
11	Tube for measuring the pressure
12	Exhalation valve
13	Bacteria filter (if used)
14	Pressure sensor G3

No.	Component
15	Magnetic valve MV 3 (Normally set as in example 1. Switches off G3 during auto-calibration, as shown in example 2.)
16	PEEP compressor

5 Removing and replacing the main components

This chapter describes how to install, remove, and/or replace the main components of the PV 403.

5.1 Removing the upper casing

1. Remove the power cord.
2. Remove the two screws (with a Torx T20 key) under the carrying handle. Remove the screw underneath the ventilator front.
3. Remove the upper casing and disconnect the ribbon cable from the CPU board.

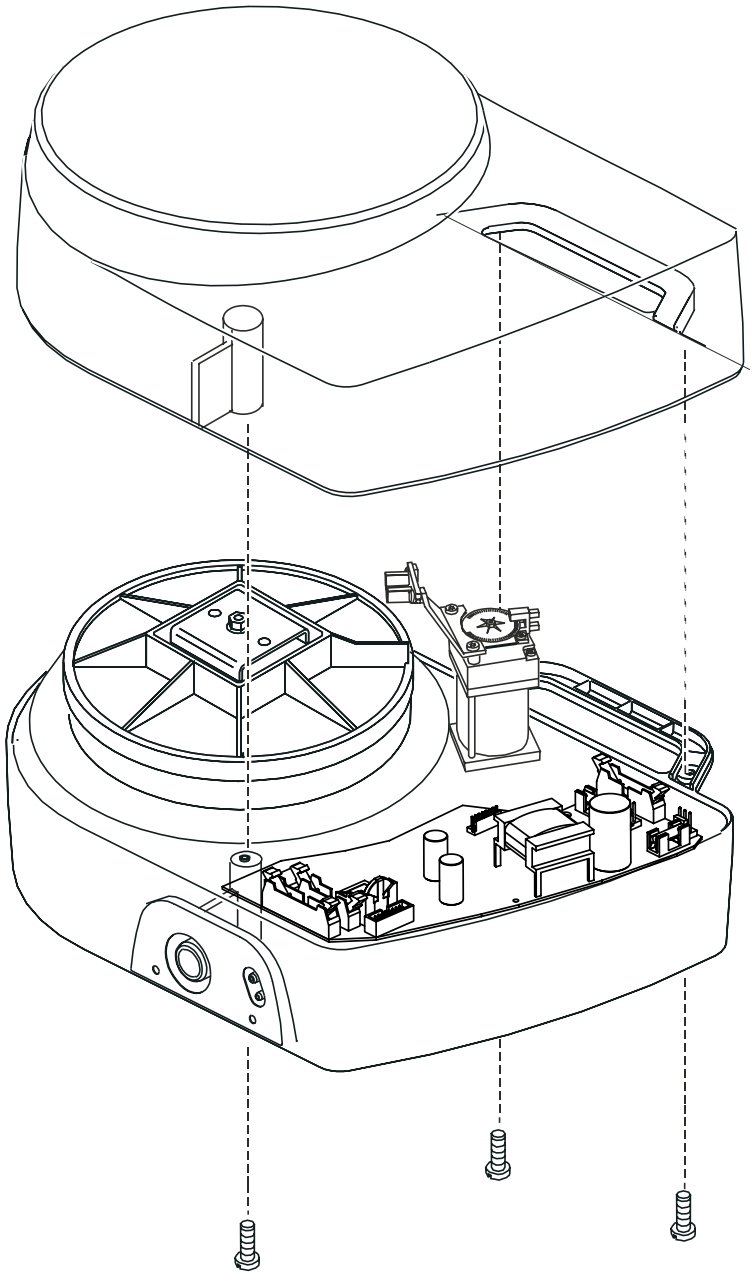


Fig. 5-a Removing the upper casing

5.2 Removing and replacing the push-button panel

1. Remove the upper casing (see section 5.1).
2. Remove the alarm board (see section 5.3).
3. Start to loosen the push-button membrane panel and label as one unit by carefully raising it up from underneath the opening in the casing for the LCD display. Continue to work the panel loose carefully until it can be removed.
4. Reassemble in the reverse order.

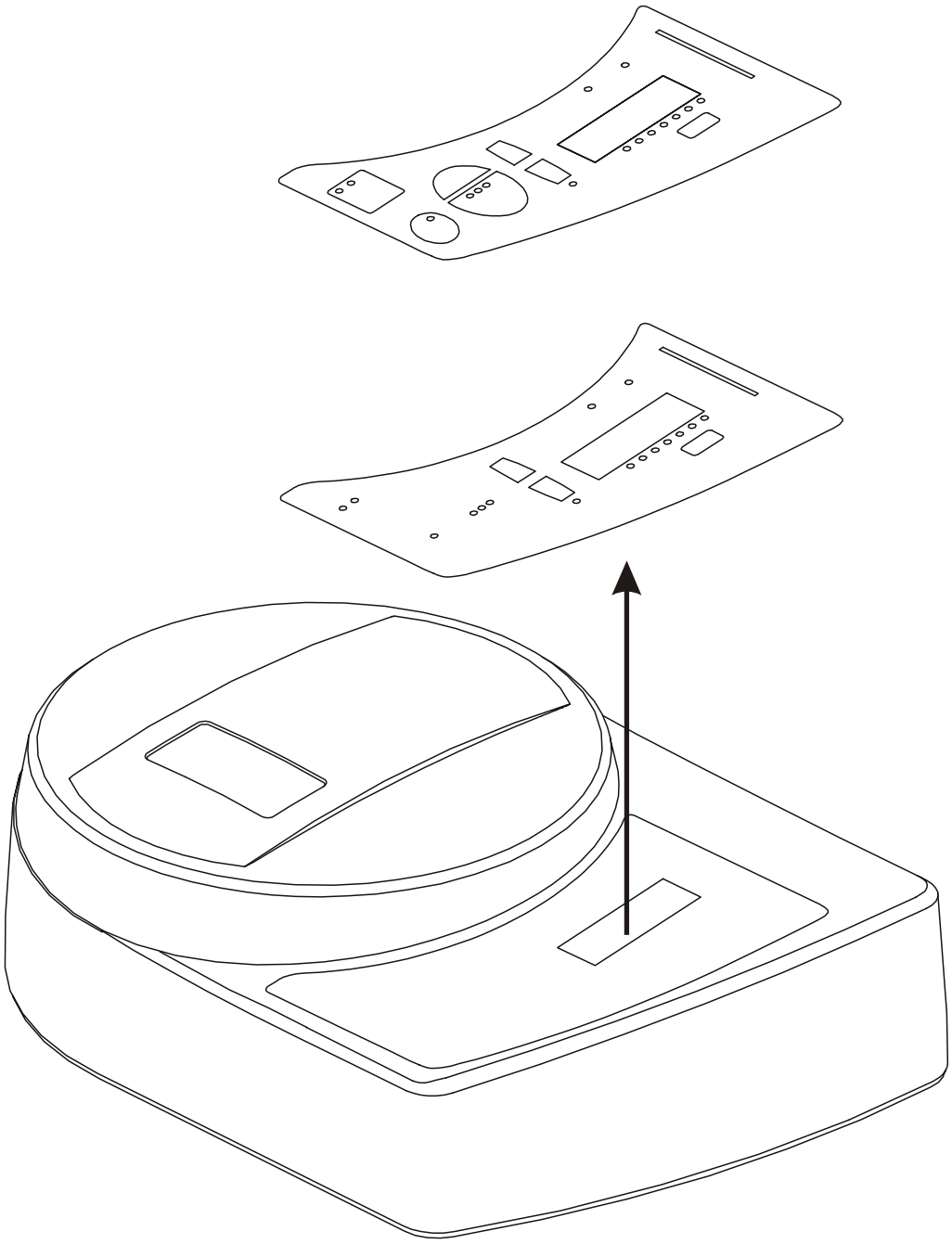


Fig. 5-b Removing the label and push-button panel

5.3 Removing and replacing the alarm board

1 Remove the upper casing (see section 5.1).

2 Disconnect the ribbon cable from the push-button membrane panel.

3 Remove the three screws that hold the alarm board and remove it.

4 Reassemble the new alarm board in the reverse order.

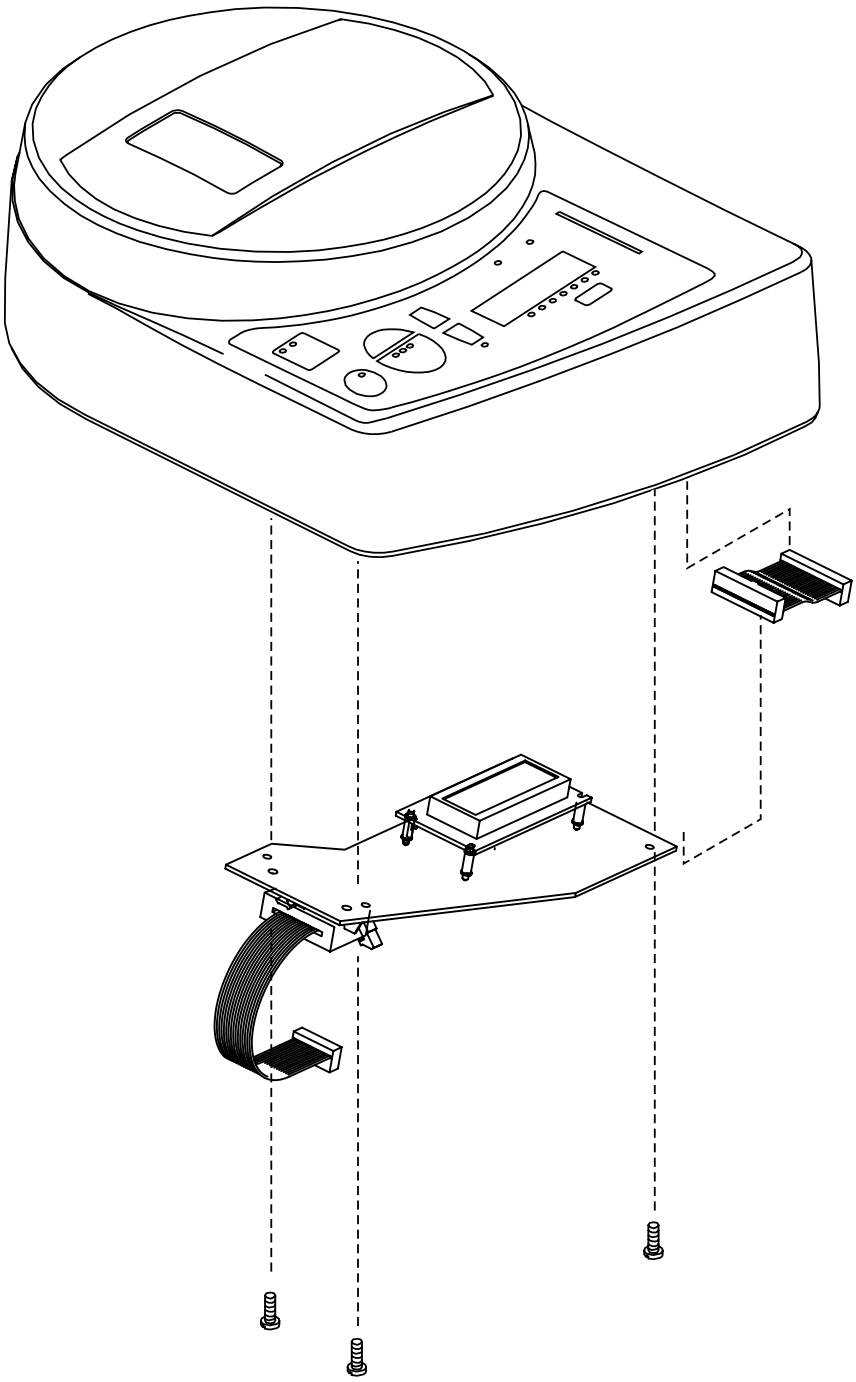


Fig. 5-c Removing the alarm board from the upper casing

5.4 Removing and replacing the CPU board

Always disconnect the ventilator from the mains when working with the CPU board.

1. Remove the upper casing (see section 5.1).
2. Disconnect all the ribbon cable connectors: the CN4 connector from the external battery, the CN1 connector from the mains inlet, and the CN2 and CN3 connectors from the motor assembly.
3. Remove the three screws holding the CPU board.
4. Lift out the CPU board.
5. Reassemble the new CPU board in the reverse order.

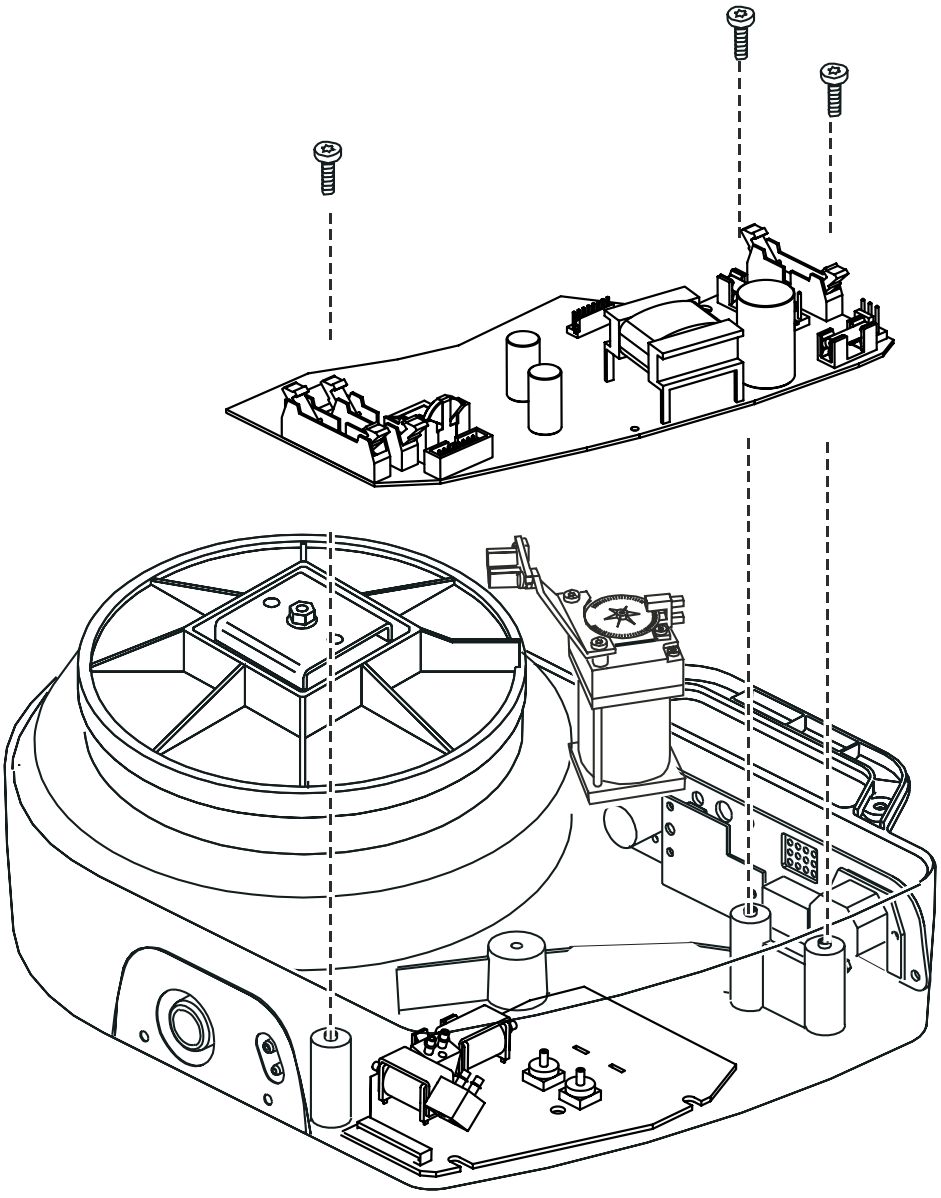


Fig. 5-d Removing the CPU Board

5.5 Installing the internal battery kit (accessory)

If an internal battery is installed and both the mains and external battery supplies fail or get disconnected, the ventilator will automatically switch to the internal backup battery supply.

5.5.1 Internal battery kit

The internal battery accessory kit contains a complete internal battery pack.

The PV 403 Operating Manual contains more information on the internal battery accessory kit.

5.5.2 Internal battery operation

Battery operation is indicated as follows:

- The LED of the On/Off button on the settings panel shows a flashing green light.
- In the Power field on the LCD display, the letter **I** (internal battery) is displayed.
- A short audible alarm sounds if the PV 403 switches to the only available backup power supply.

The internal battery pack will last for a total operating time of

- at least 60 minutes with the rate and the pressure set to the highest possible setting,
- at least 2 hours with normal settings – the pressure set to 20 mbar, the rate to 12 breaths per minute, and the inspiration time set to 1.5 seconds.

5.5.3 Installing the internal battery pack

1. Turn the ventilator upside down.
2. Remove the small rubber plug to access the terminals for the internal battery wires.
3. Remove the five screws from the base plate.
4. Connect the connector from the internal battery pack to the terminal. Make sure they are connected correctly (see figure below).
5. Fit the internal battery pack, making sure that no wires are pinched. Fix it in place with the original screws.
6. Turn the ventilator over and stand it on its rubber feet.

The internal batteries are charged while the ventilator is connected to the mains supply, even when the ventilator is switched off.

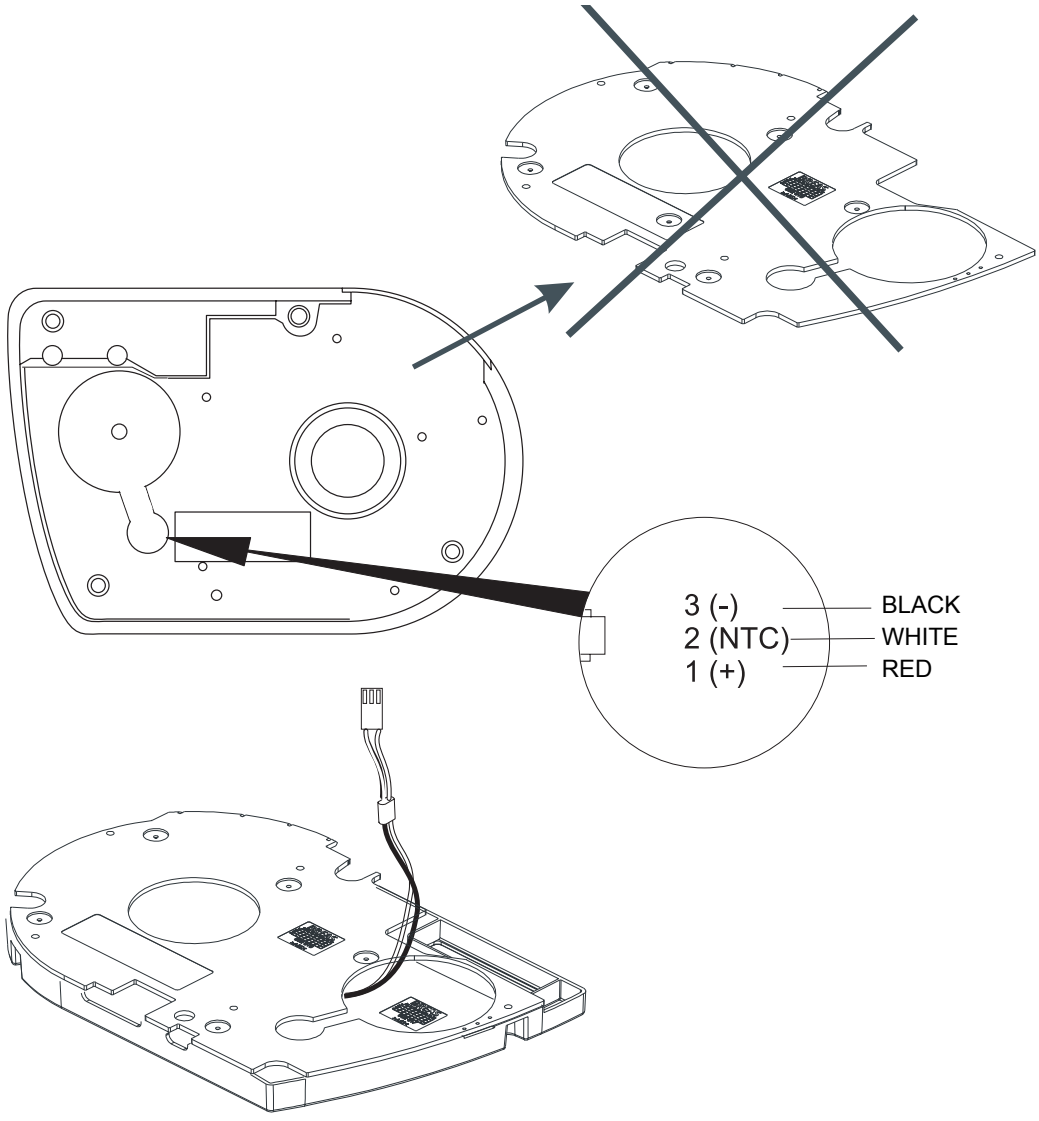


Fig. 5-e Installing the internal battery pack

5.5.4 Removing the internal battery pack

- Remove the internal battery pack by following in reverse order the instructions in section 5.5.3 above.

5.6 Removing and replacing the PGC board

1 Remove the upper casing (see section 5.1).

2 Remove the CPU board (see section 5.4).

3 Remove the ribbon cable from the CPU board.

4 Mark the hoses using a marker pen and detach them from their connectors.

5 Remove the three screws holding the PGC board.

6 Reassemble in the reverse order.

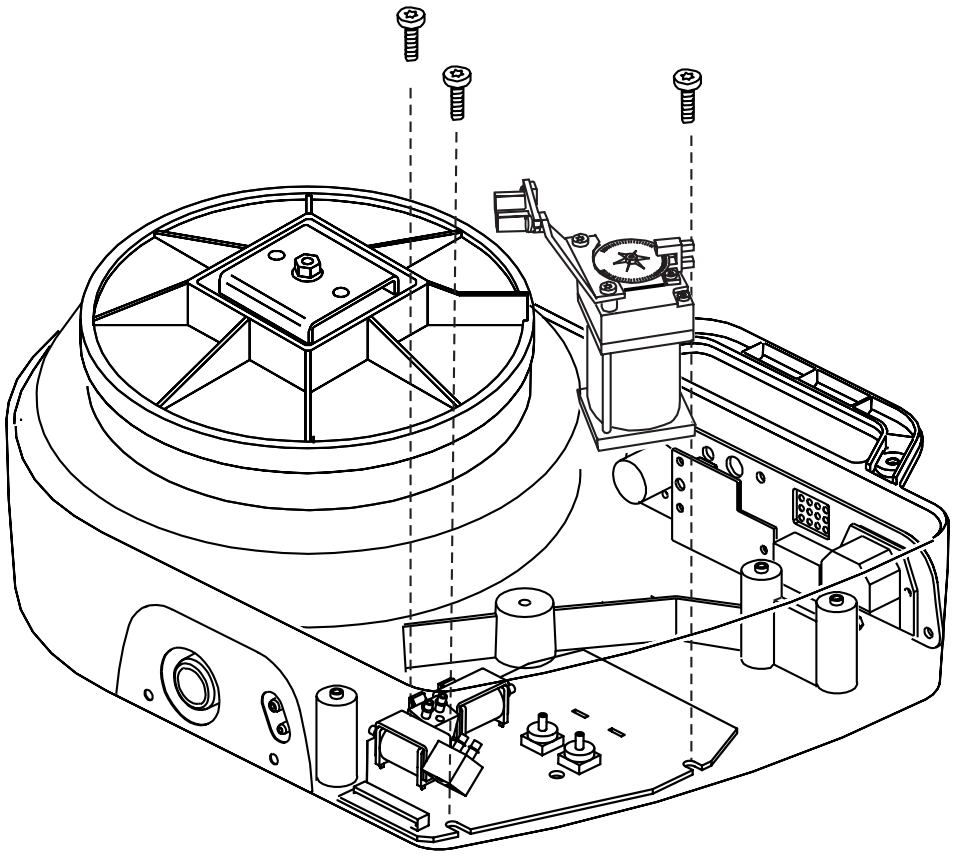


Fig. 5-f Removing the PGC Board

5.7 Removing and replacing the PEEP compressor

1. Remove the upper casing (see section 5.1).
2. Remove the CPU board (see section 5.4).
3. Detach the hose from the PEEP compressor.
4. Disconnect the connector from the PGC board.
5. Lift out the PEEP compressor.
6. Reassemble in the reverse order.

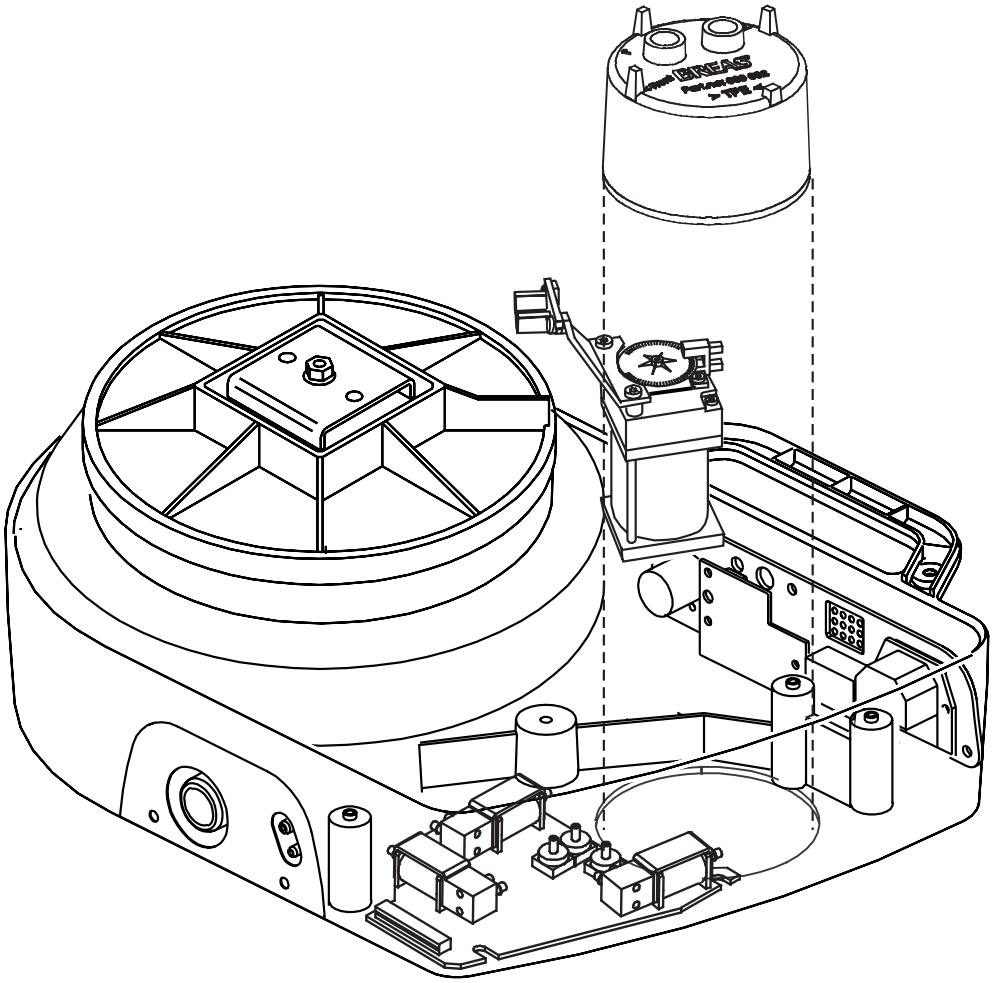
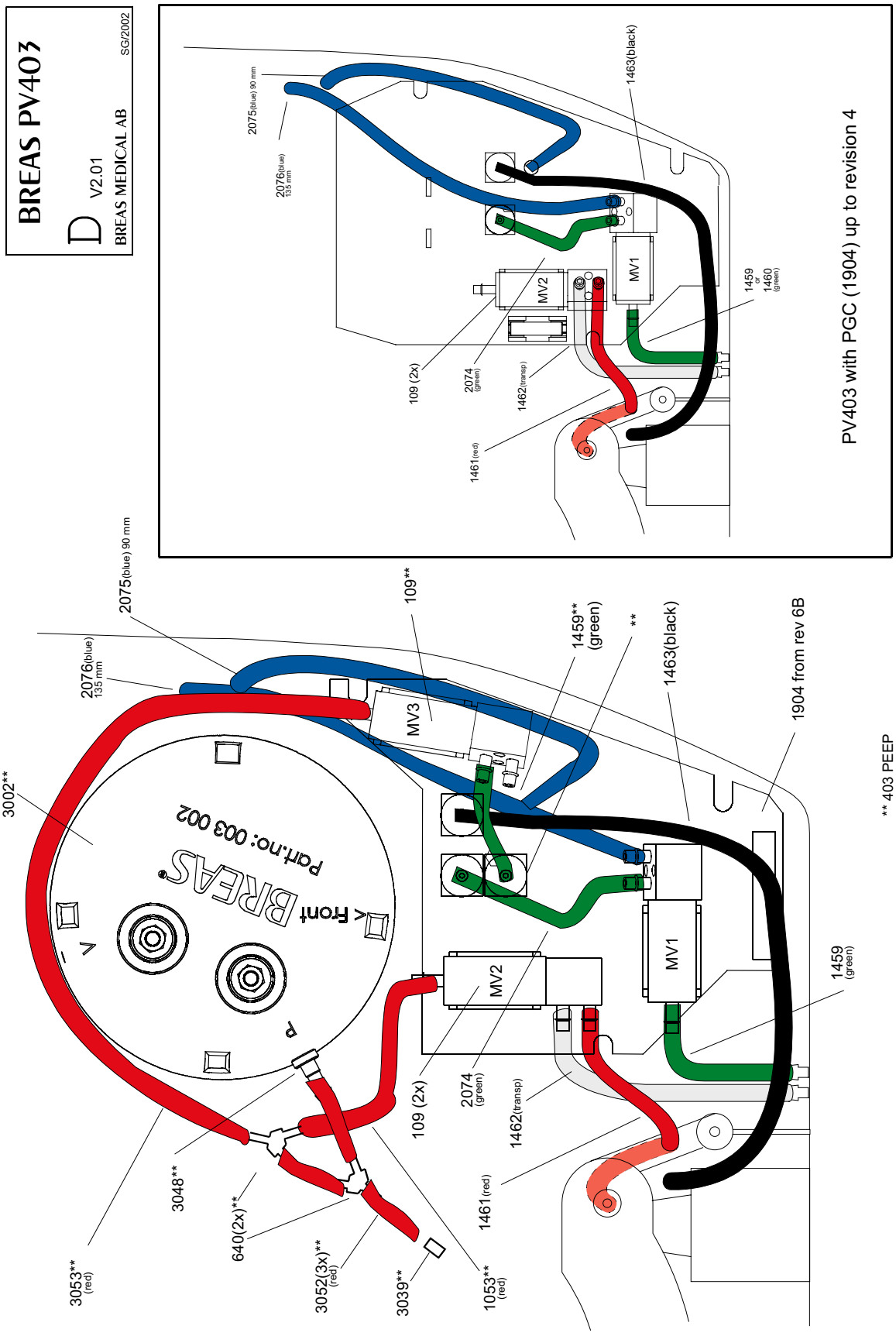


Fig. 5-g Removing the PEEP connector

5.8 Location of the air tubes

This figure shows the location of the air tubes.



5.9 Removing and replacing the rear panel

1 Remove the three screws (1) from the rear panel.

2 Disconnect the connector (2) from CN1 on the CPU board.

3 Disconnect the connector for the external battery supply (3) from CN4 on the CPU board, and the mains connector (4) from CN1 on the CPU board.

4 Disconnect the ribbon cable from CN6 on the CPU board.

5 Push the rear panel and label outwards from inside the lower casing.

6 Remove the entire assembly.

7 Reassemble in the reverse order.

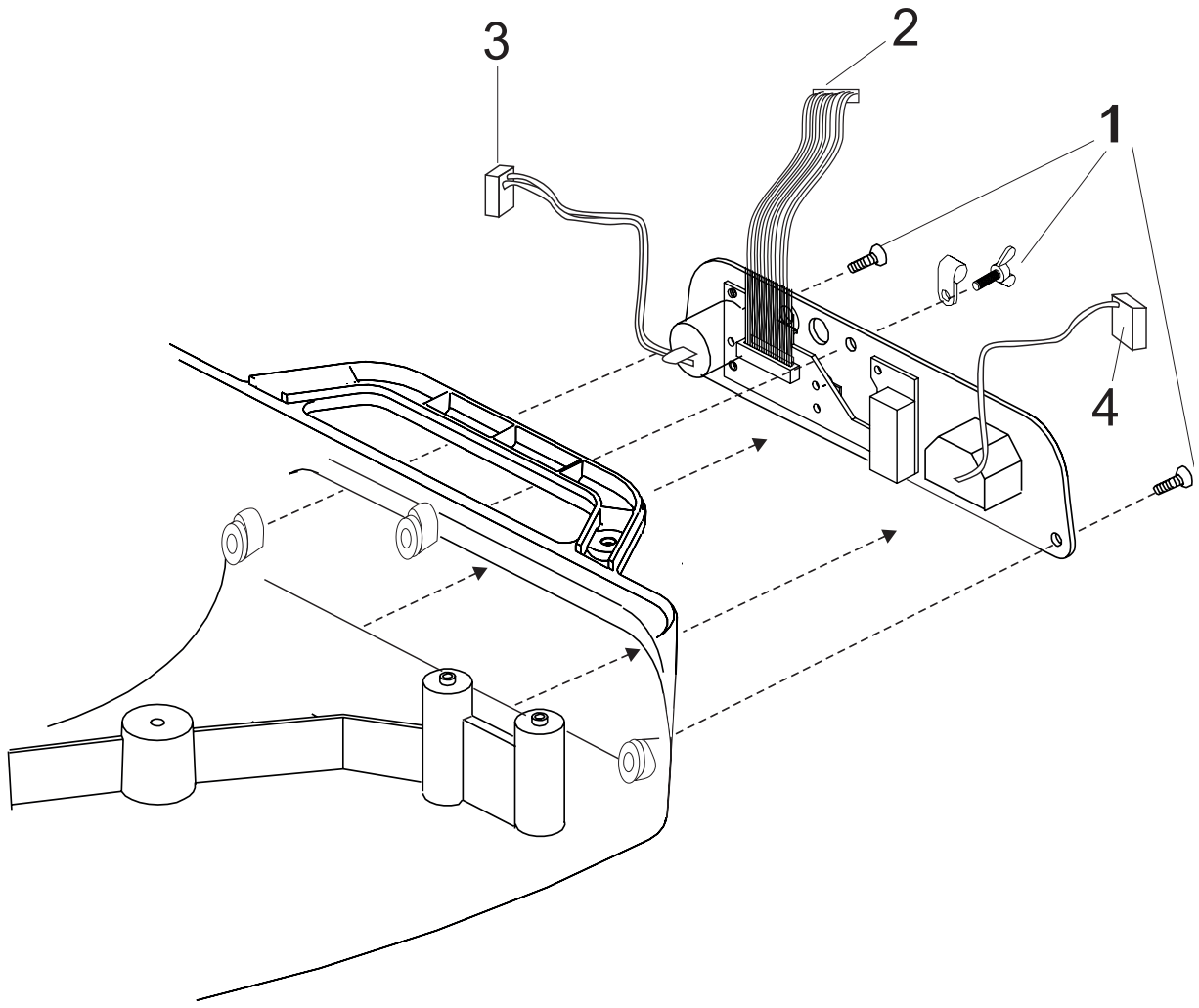


Fig. 5-h Removing the rear panel

5.10 Removing and replacing the I/O board

1 Disconnect the ribbon cable to the CPU board.

2 Remove the five nuts that hold the CPU board and lift it out.

3 Reassemble in the reverse order.

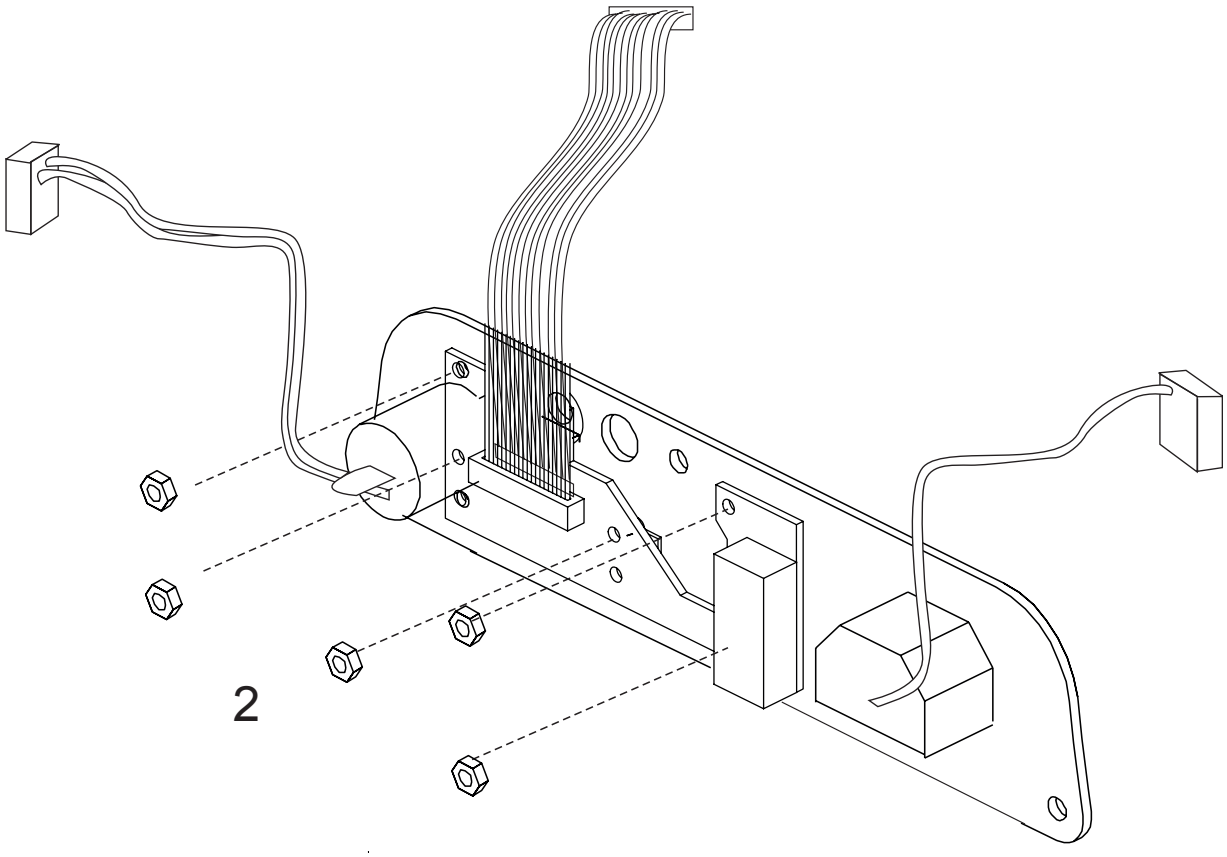


Fig. 5-i Removing the I/O board

5.11 Removing the motor assembly from the lower casing

The following tools are required:

- Torx key, size 20 mm
- 7 mm socket with extension

1 Remove the internal battery pack, if installed (see section 5.5.3).

2 Remove the filter cassette.

3 Remove the base plate. Remove the five fastening screws (if no internal battery is installed).

4 Remove the upper casing (see section 5.1).

5 Remove the four 7 mm nuts (5) from underneath the PV 403 that hold the motor assembly.

6 Disconnect the CN 2 and CN 3 connectors.

7 Grip the motor assembly firmly and lift it straight up from the lower casing.

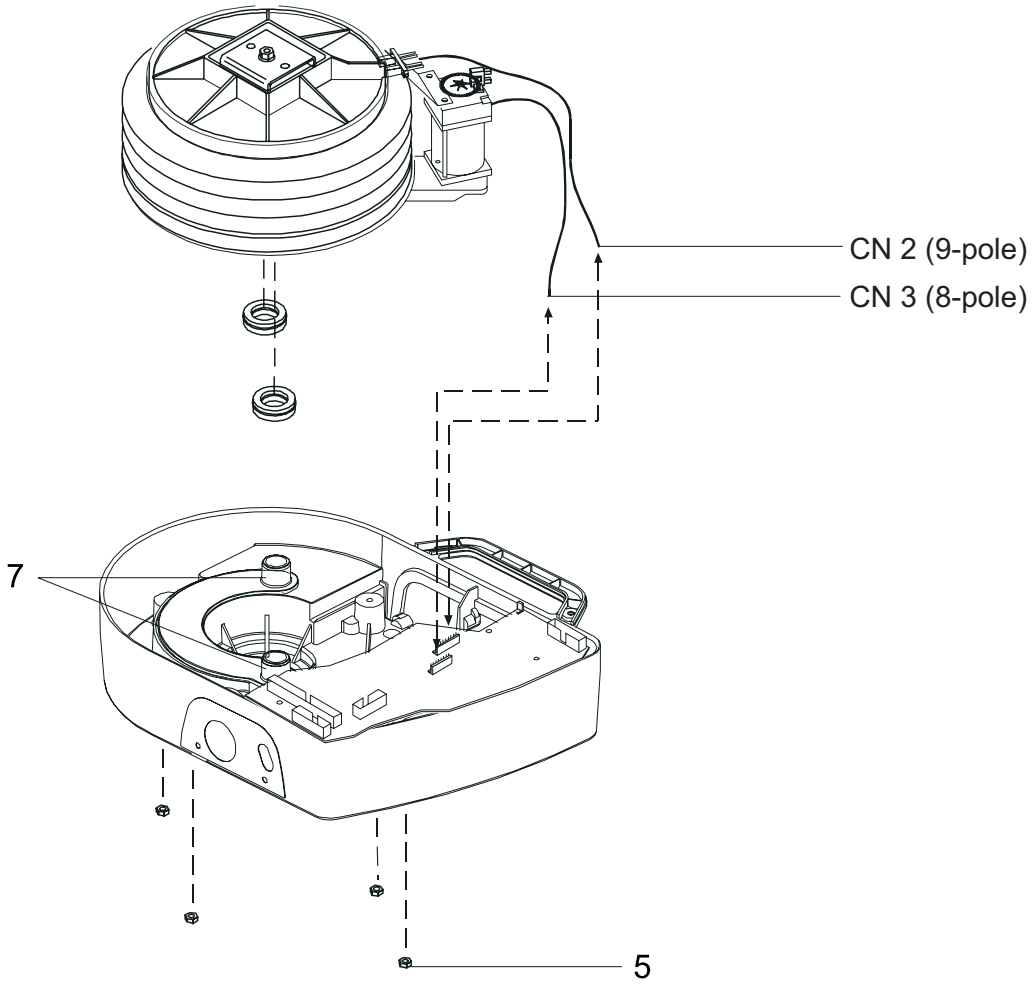


Fig. 5-j Removing the motor assembly

5.12 Reassembling and replacing the motor assembly

1. Apply a little soapy water to the inside of the two seals and their corresponding connectors in the lower casing (see figure Fig. 5-k).
2. Carefully push the motor assembly into place. At the same time check that the mounting bolts are aligned with their respective holes.
3. Fasten the motor assembly in place with the four 7 mm nuts (see figure Fig. 5-j). Tighten crosswise using hand pressure.
4. Reconnect the CN 2 and CN 3 connectors (see figure Fig. 5-j). Make sure that all the cabling is routed correctly before fitting the upper casing.
5. Fit the ribbon cable connector to the CPU board.
6. Fit the upper casing (see section 5.1). Fasten with the screw behind the patient air outlet and with the two screws for the carrying handle.
7. Fit the five Torx screws that hold the base plate.
8. Fit the filter cassette. If the filter cassette has a tight fit, slacken the screws nearest to the cassette a little so that the cassette can be easily pulled out.
9. Reconnect the internal battery pack, if installed (see section 5.5.3).
10. Start the ventilator and run a function test before putting it back into use.

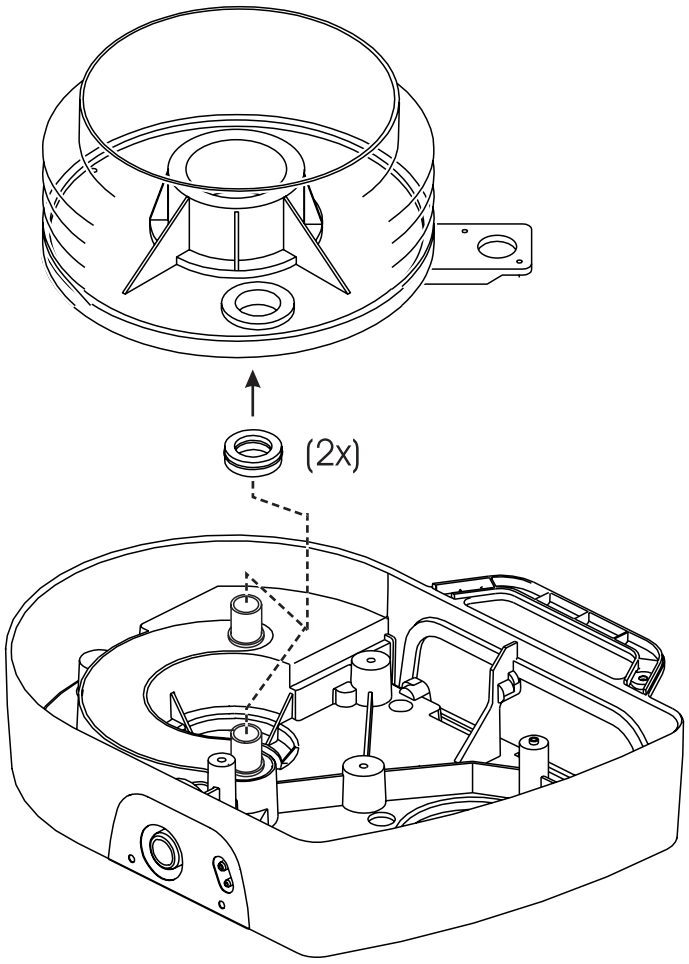


Fig. 5-k Fitting the silicon rubber seals before assembly

6 Motor assembly

This chapter describes the main components of the motor assembly and how to service and maintain it.

6.1 Main components of the motor assembly

The figure below shows the main components of the motor assembly.

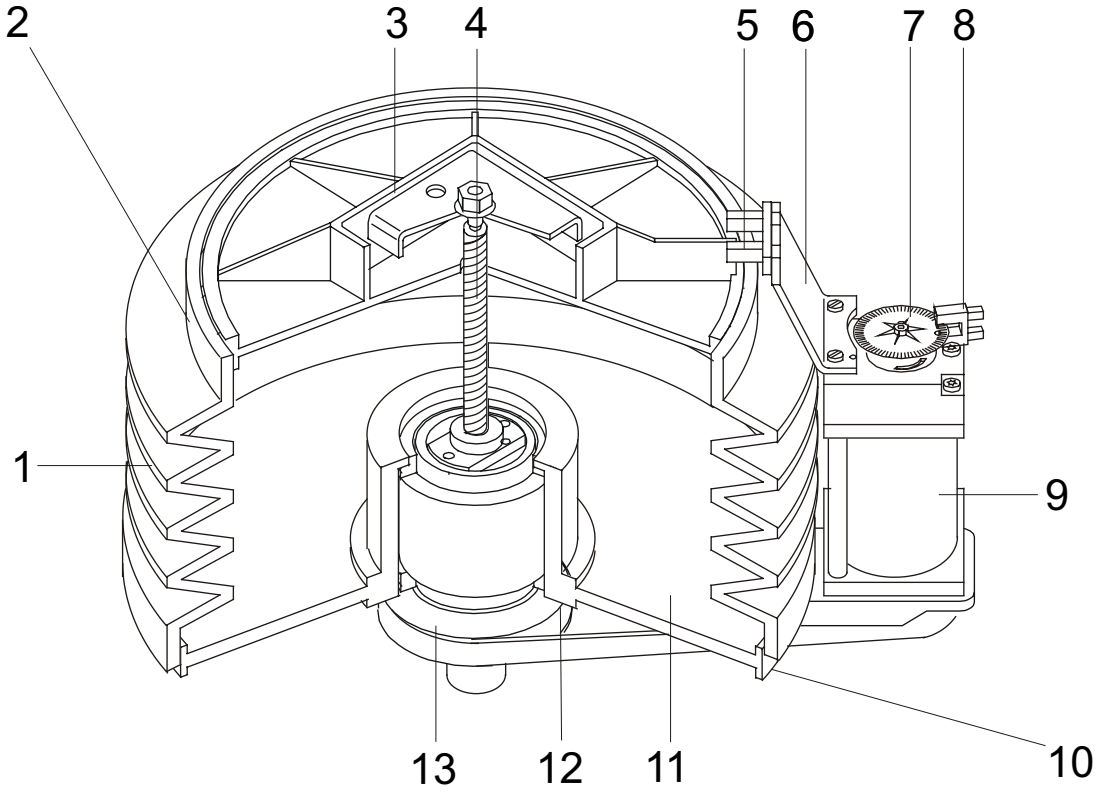


Fig. 6-a The PV 403 motor assembly

The table below lists the main components of the motor assembly.

No.	Description
1	Bellows
2	Bellows clamp, upper, steel
3	Bellows top cover
4	Ball screw
5	Optoswitch
6	Optoswitch bracket
7	Slotted disc
8	Encoder
9	Motor
10	Bellows clamp, lower, steel
11	Bellows bottom cover
12	Driving belt pulley
13	Driving belt

6.2 Removing the motor assembly

Refer to section 5.11 for instructions on how to remove the motor assembly.

6.3 Inspecting and replacing the driving belt

This operation is done with the motor assembly removed from the casing. See section 5.11 for instructions on how to remove the motor assembly.

1 While turning the large pulley, work the driving belt off (see no. 13 in Fig. 6-a).

2 Check that the driving belt and the pulley surfaces are undamaged. Replace the belt at the specified service interval or when necessary.

3 Reassemble the motor assembly and the casing (see section 5.12).

6.4 Lubricating the ball screw

The ball screw can be lubricated without removing the motor assembly.

1 Remove the two screws, the spacer, and the nuts that hold the optoswitch bracket to the motor. Move the optoswitch assembly to one side.

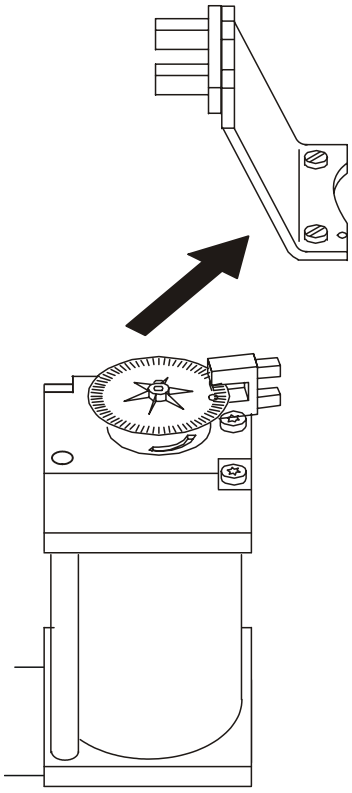


Fig. 6-b Removing the optoswitch bracket

2 Run the bellows up to its top turning point.

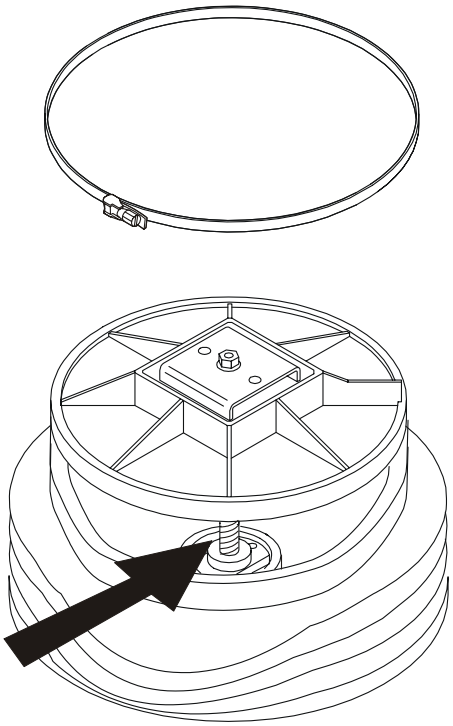


Fig. 6-c Lubricating the ball screw

3 Remove the upper bellows clamp and pull the bellows from the top end cover.
4 Wipe away any old grease and dirt from the ball screw.
5 Apply new grease, BREAS part no. 000557.
6 Run the ball screw up and down a couple of times and remove any excess grease.
7 Fit the bellows to the end cover and fasten it with the bellows clamp.
8 Fit the optoswitch assembly to the motor.

6.5 Replacing the membranes in the check valves

This operation is done with the motor assembly removed from the casing. See section 5.11 for instructions on how to remove the motor assembly.

6.5.1 Equipment

Before you start make sure you have a service kit at hand that contains:

- two membranes,
- two O-rings for the membrane seats,
- the sealing ring for the patient air outlet,
- one driving belt.

6.5.2 Replacing the check valve membrane under the air channel

1 Remove the two screws from underneath the ventilator that hold the retainers for the check valve (indicated by the arrows in the figure below).

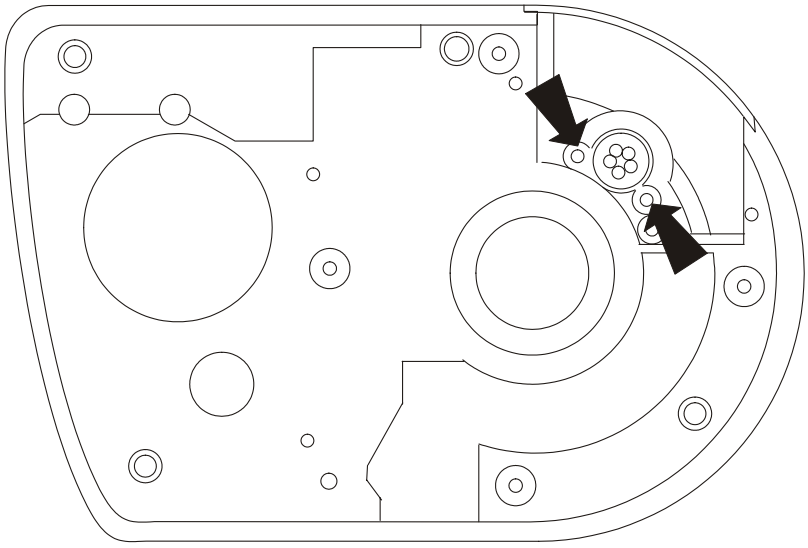


Fig. 6-d Removing the two screws that hold the check valve

2 Press out the check valve from above using a suitable tool, for example, an 8 mm socket, to protect the plastic centre pin of the valve.

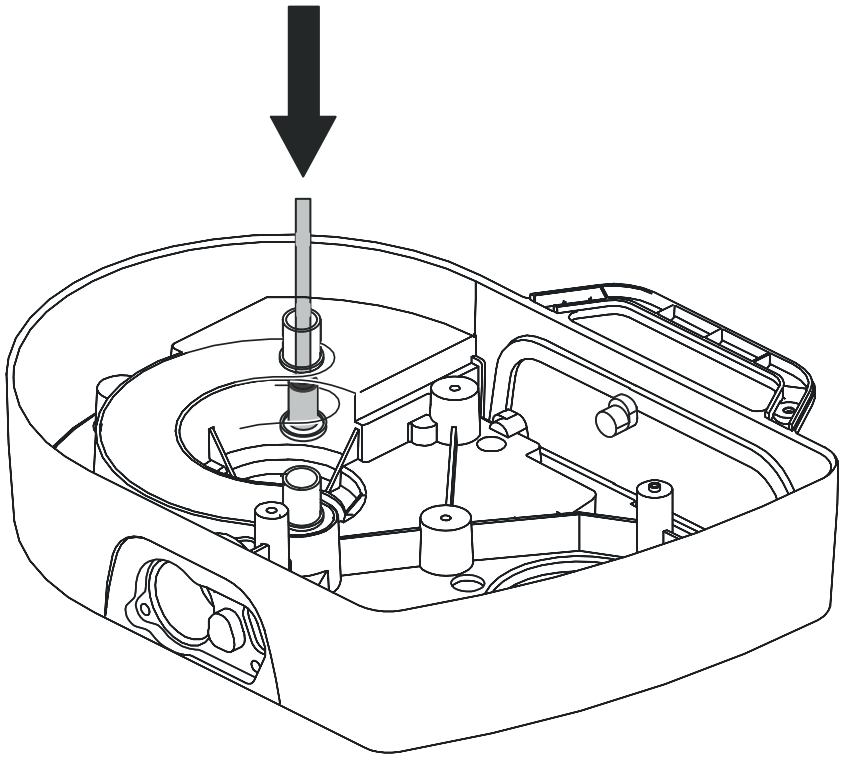


Fig. 6-e Pressing out the check valve from inside the air channel

3 Pull the membrane from the valve seat and remove the O-ring.

4 Wipe the membrane seat with a damp cloth.

5 Fit the new membrane and O-ring, making sure that they are seated snugly.

6 Reassemble in the reverse order.

6.5.3 Replacing the check valve membrane in the patient air outlet

1 Disconnect the white and green tubes from their connectors behind the patient air outlet moulding.

2 Remove the two screws (1) from the front panel. Remove the panel overlay (2).

3 Remove the screw (3) that holds the patient air outlet.

4 Pull out the patient air outlet assembly.

5 Press out the plastic valve seat and membrane using a suitable tool, for example, an 8 mm socket, to protect the plastic centre pin.

6 Wipe the membrane seat clean using a damp cloth.

7 Carefully fit the new membrane.

8 Make sure that the new membrane lies flat against its seat.

9 Fit a new O-ring (4) to the tube connector and screw it back in place.

10 Reassemble in the reverse order. Do not forget to fit the new O-ring (5) and rubber seal (6).

11 Perform a leakage check to confirm that the check valves function correctly.

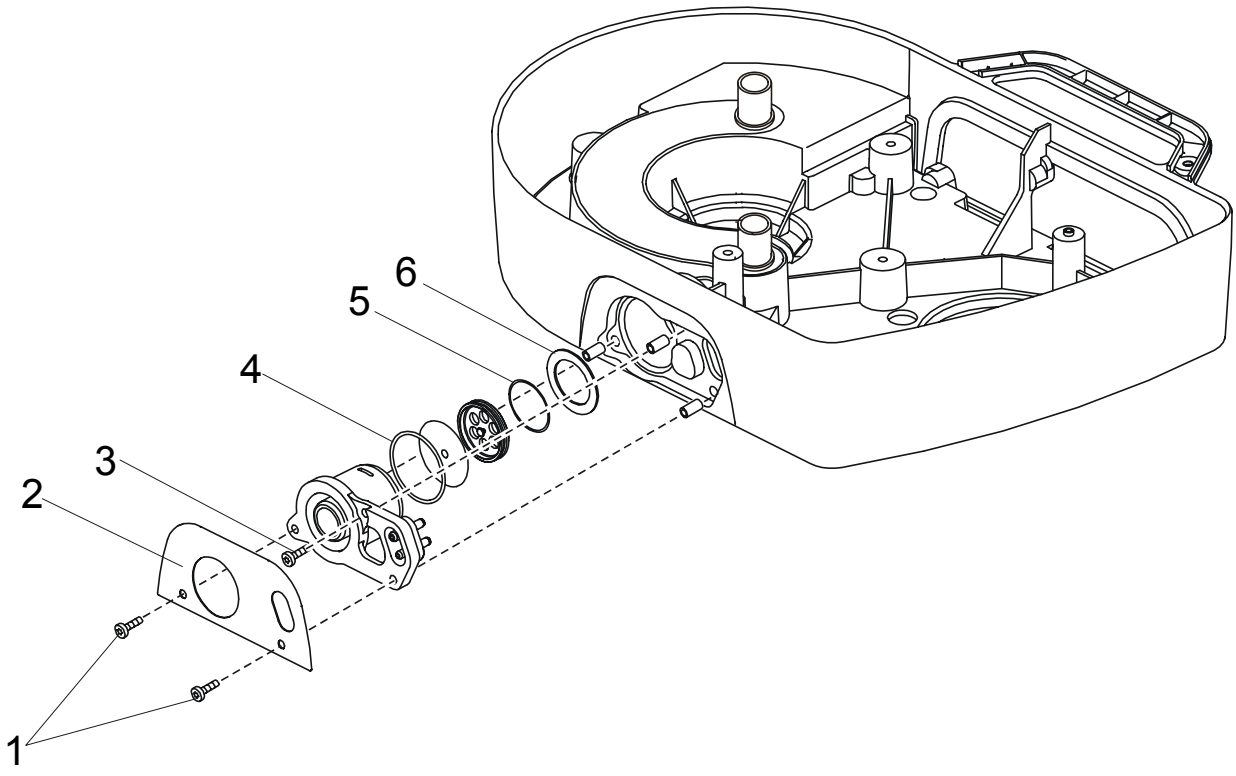


Fig. 6-f Replacing the membrane in the patient air check valve

6.6 Testing for leakage from the tubes and bellows

6.6.1 With open ventilator casing

1 Open the upper casing so that you can access the settings panel (see Fig. 6-b). The ribbon cable to the CPU board must remain connected.

Make sure the home position optoswitch is not exposed to bright light when the ventilator casing is open (see figure below).

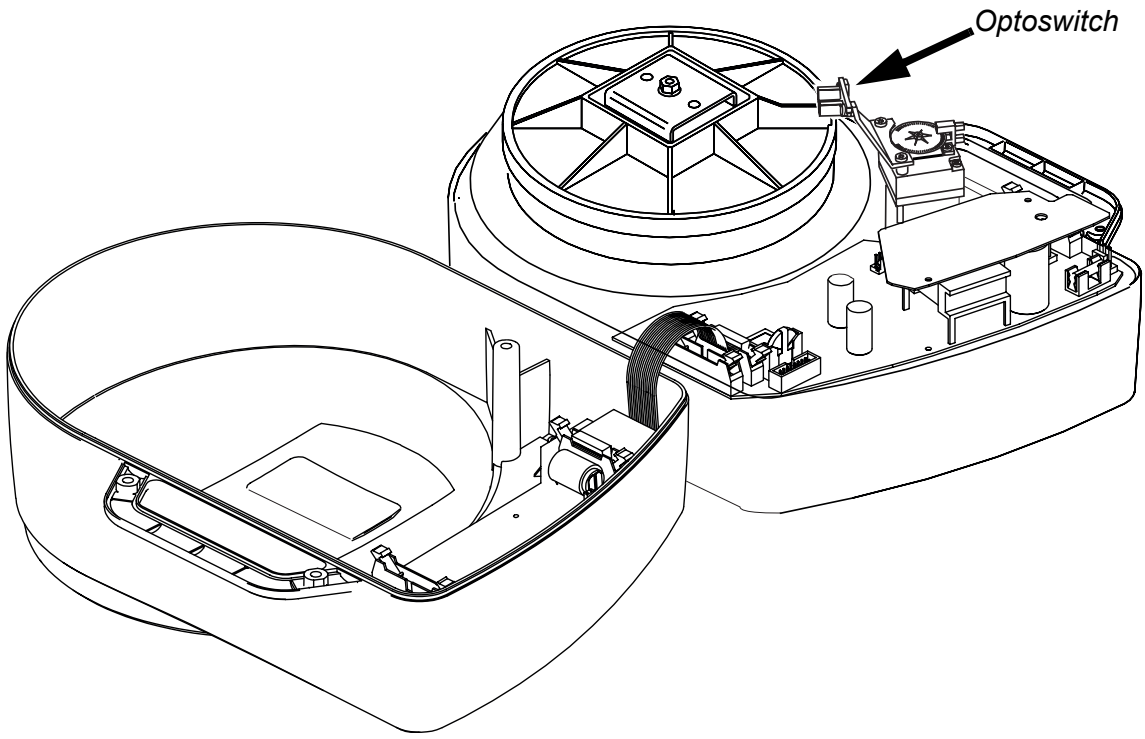


Fig. 6-g Opening the upper casing

2 Check that the bellows has not worked loose from its end covers.

3 Check that the bellows clamps are properly tightened.

4 Connect the mains power supply or an external 24 V battery and switch on the ventilator.

5 Connect the patient circuit to a test lung/reservoir bag.

6 Set the following parameters:

Pressure	40 mbar
Rate	6 BPM
Insp. time	5.0 seconds
Mode	PCV

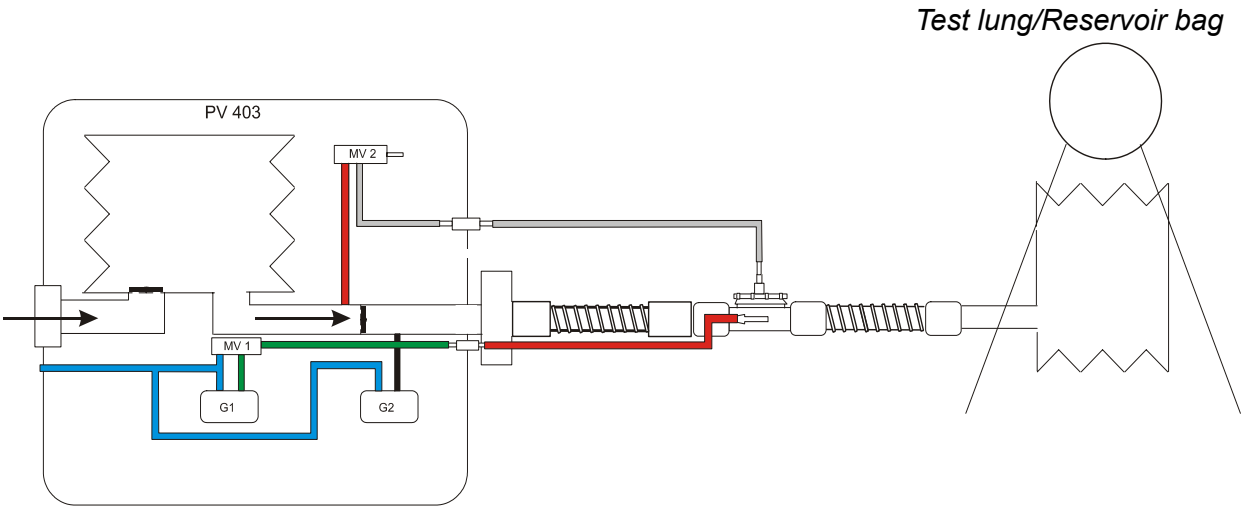


Fig. 6-h Leakage check of tubes and bellows

7 Check that the motor stops when the pressure has reached 40 mbar.
If there are any leaks the motor will continue to work to compensate for the air lost.

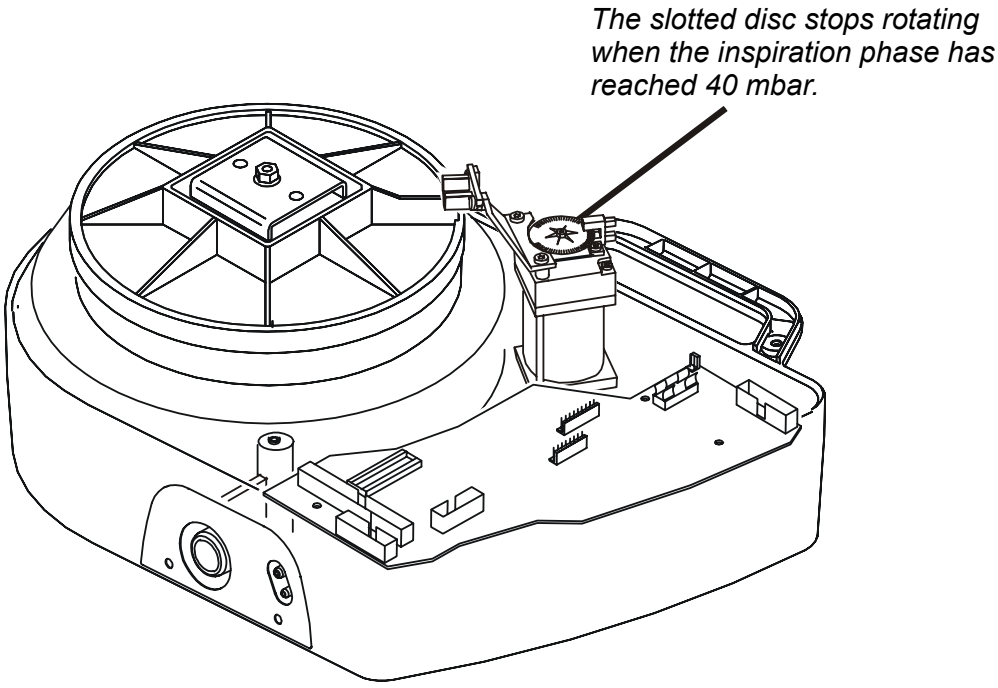


Fig. 6-i Slotted disc

6.6.2 With closed ventilator casing

1 Adjust the setting as described in section 6.6.1.

2 Block the patient air outlet and the exhalation air outlet.

3 The tidal volume should now indicate 0.10 litres or less.
If the tidal volume is higher than 0.10 litres there is a leak.

6.7 Replacing the ball screw assembly

1 Remove the motor assembly (see section 5.11).

2 Remove the two screws holding the optoswitch bracket to the motor. Move the bracket to one side.

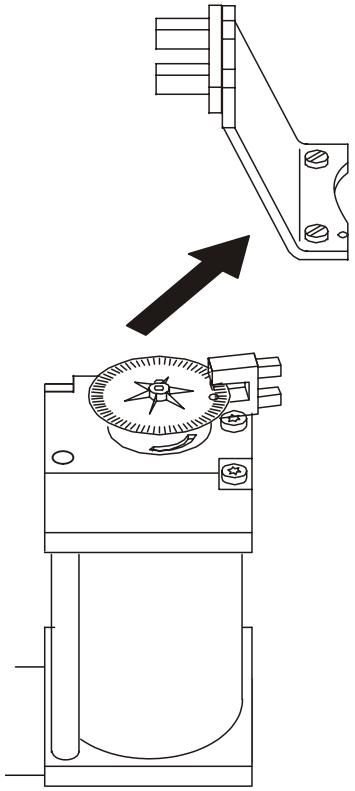


Fig. 6-j Removing the optoswitch bracket

3 Remove the upper bellows clamp. Drive the top end cover upwards by turning the belt pulley.

4 To avoid damaging the bellows remove the lower bellows clamp and the bellows.

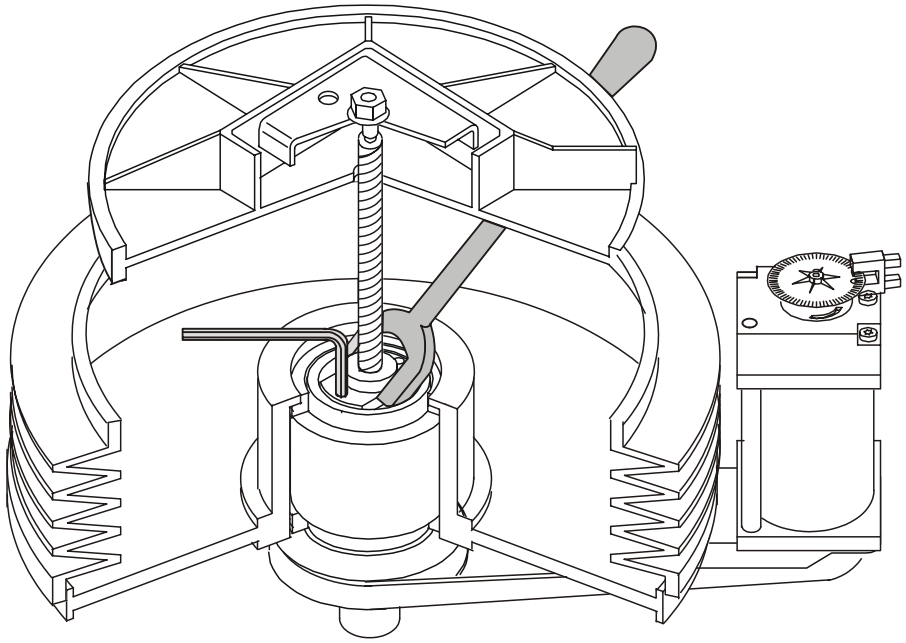


Fig. 6-k Removing the ball screw

5 Use the special tool as a counterhold for the retainer plate. Remove the two Torx screws using an angled Torx key.

6 Remove the complete ball screw assembly from the bearing housing.

7 Fit the ball screw assembly into the bearing housing.

8 Use the special tool as a counterhold for the retainer plate. Screw in and tighten the two Torx screws.

9 Grease the ball screw if necessary (see section 6.4).

10 Fit the bellows and clamps and tighten them.

11 Fit the optoswitch bracket.

12 The motor assembly can now be reinstalled.

6.8 Replacing the bearing housing assembly

This operation is carried out with the motor assembly removed from the ventilator.

1. Remove the ball screw assembly (see section 6.7).
2. Turn the unit upside down.
3. Unscrew the red plastic protection cap (1).
4. Remove the four Allen screws (2) that hold the lock ring (3) and unscrew it from the ball screw shaft.
5. Pull the belt pulley (4) off the shaft.
6. Remove the four Torx screws (5) that hold the retainer ring (6). Remove the retainer ring.

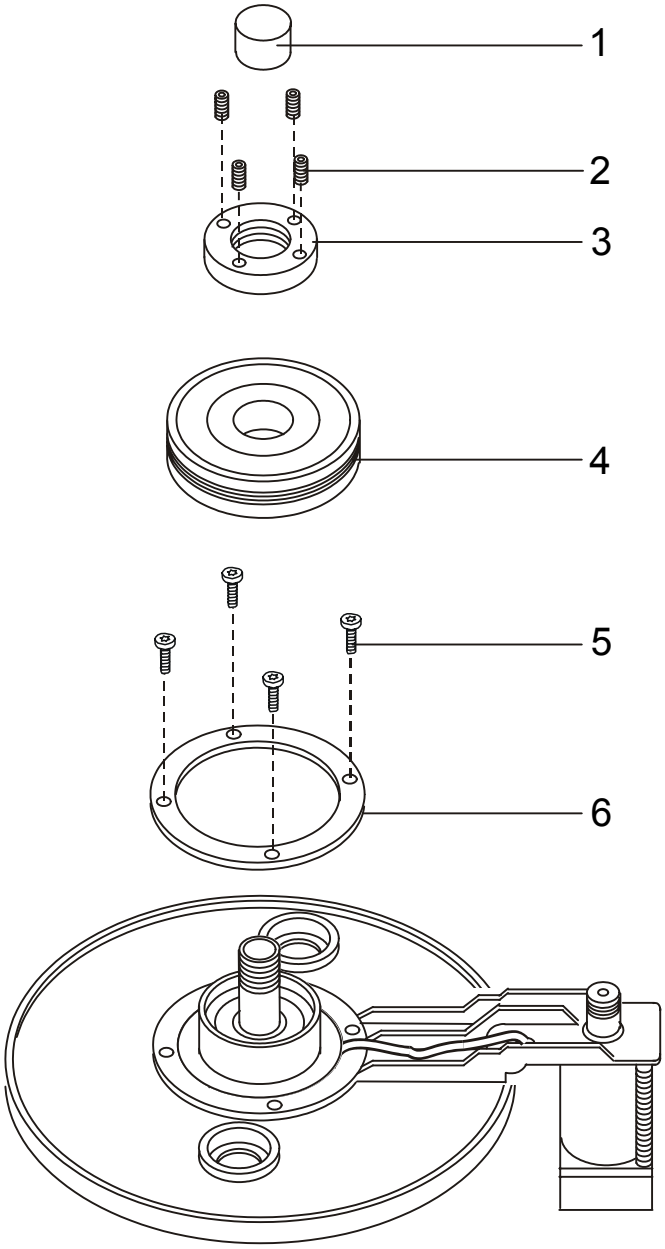


Fig. 6-I Removing the bearing housing

7 From above, press the bearing housing (7) out of the moulding. Be careful not to damage the two silicon-rubber seals (8 and 9).

8 Replace the bearing housing.

9 Fit the upper silicon-rubber seal inside the lower moulding up against the lip.

10 Fit the lower silicon seal to the bearing housing assembly.

11 Lubricate the seals with a little soapy water to make the assembly easier.

12 From below, press the bearing assembly into place. Make sure that the black earth wire (10) is fixed between the lower silicon-rubber seal and the bearing housing.

13 Fit the retainer ring (6) and fasten in it place with the four Torx screws (5).

14 Fit the belt pulley on the shaft (4).

15 Screw on the locking ring (3) and tighten the four Allen screws (2) that hold it in place.

16 Screw on the red plastic protection cap (1).

17 Install the ball screw assembly (see section 6.7).

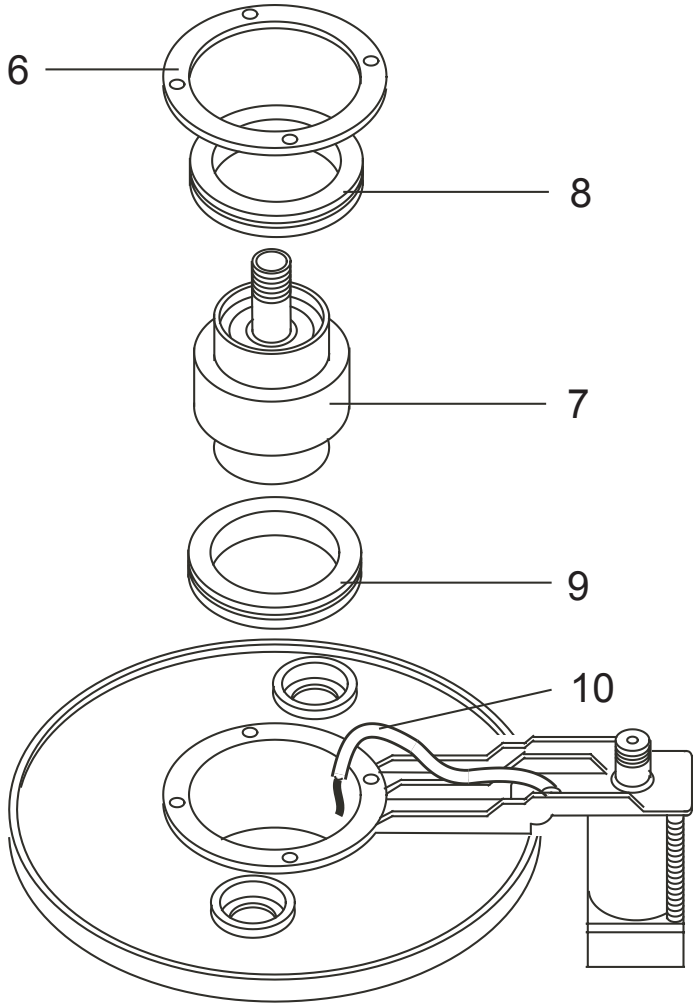


Fig. 6-m Removing the bearing housing from underneath the lower end cover

7 Pressure calibration and firmware upgrade

This chapter describes how to calibrate the pressure sensors of the PV 403 manually or automatically and how to use the BREAS calibration software to upgrade the PV 403 firmware.

After a calibration or upgrade, always check the patient settings of the ventilator.

7.1 Introduction to the pressure calibration process

The pressure sensors of the PV 403 must be calibrated and verified if the CPU or PGC board has been replaced.

7.1.1 Calibration process

To calibrate the PV 403 you need the PV 403 calibration software from BREAS Medical and some additional equipment (see section below). A Thommen digital manometer can be used to calibrate the ventilator automatically.

When the calibration is complete the calibration data for the installed pressure sensor is saved in the data memory of the ventilator.

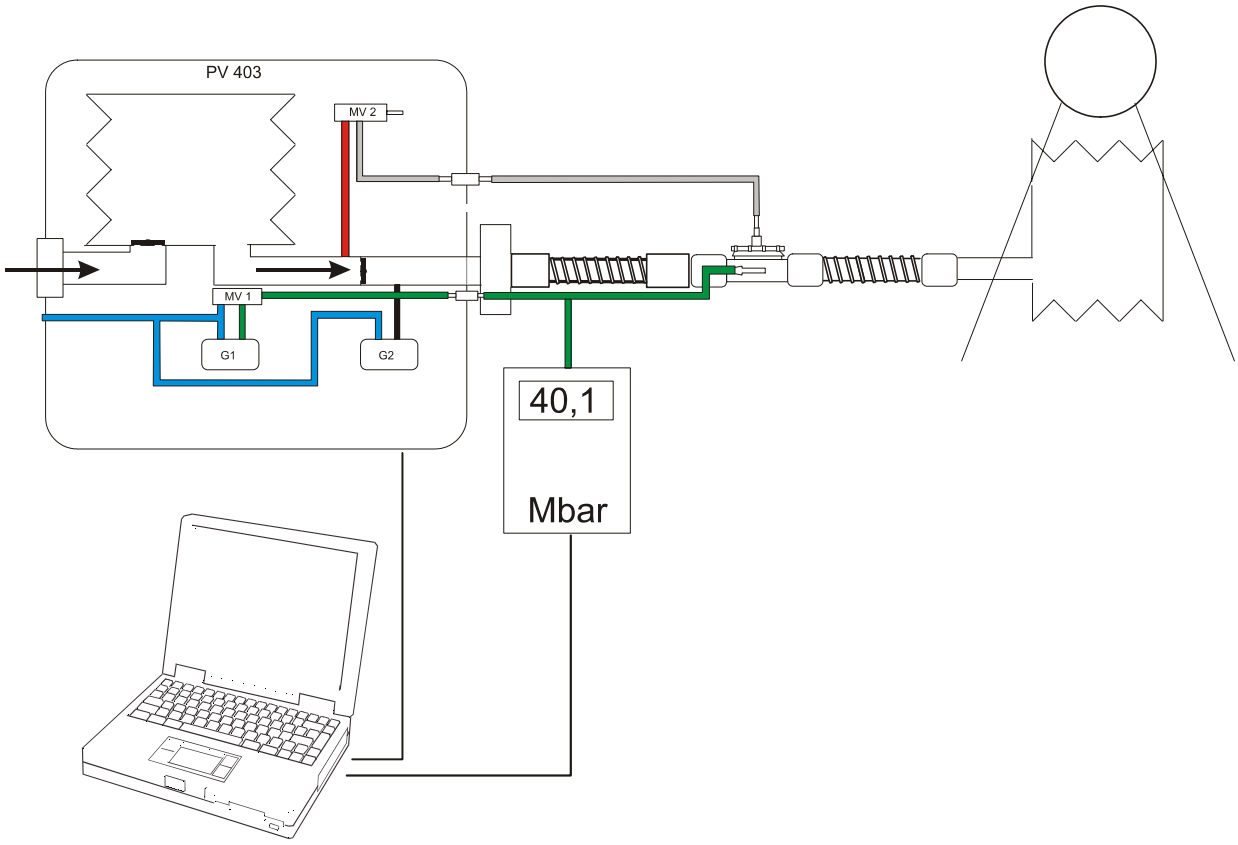


Fig. 7-a Calibration process

7.1.2 Calibration equipment

The following equipment is required for calibrating the pressure sensors of the PV 403:

Equipment	Comment
Pressure reference manometer	Used for manual calibration. Measuring range 0–60 mbar with tolerance ±1 mbar or better
Thommen HM 28 digital manometer	Part no. 001934 • Optional for manual calibration, replaces the manual pressure reference manometer • Necessary for automatic calibration
Connector for the pressure gauge to the PV 403	
A PC running Windows 95, or later	• Automatic calibration: PC must have two available COM ports if a Thommen pressure gauge is used • Manual calibration: PC must have at least one COM port
Computer cable with 25-pin connector to the PV 403	Part no. 001980
PV 403 pressure calibration software	Supplied on the installation CD, part no. 001703
Test lung	Part no. 001917
Patient circuit	Part no. 000402

7.1.3 Pressure sensors

The PV 403 has two pressure sensors, G1 and G2, that are located on the PCG board.

Pressure sensor	Description
G1	Monitors the pressure at the exhalation valve and displays the value at the pressure gauge
G2	Pressure regulator sensor

7.1.4 Installing the calibration software

1. Insert the CD in the computer and follow the on-screen instructions to install the PV 403 pressure calibration software.
   See the readme file for more information.
2. To install the LabView RunTime program, select **LabView RunTime** in the file directory structure, select the version, click **Install**, and follow the on-screen instructions.
3. To install the BREAS calibration software, select **PV 403** in the file directory structure, select **Calibration**, click **Install**, and follow the on-screen instructions.

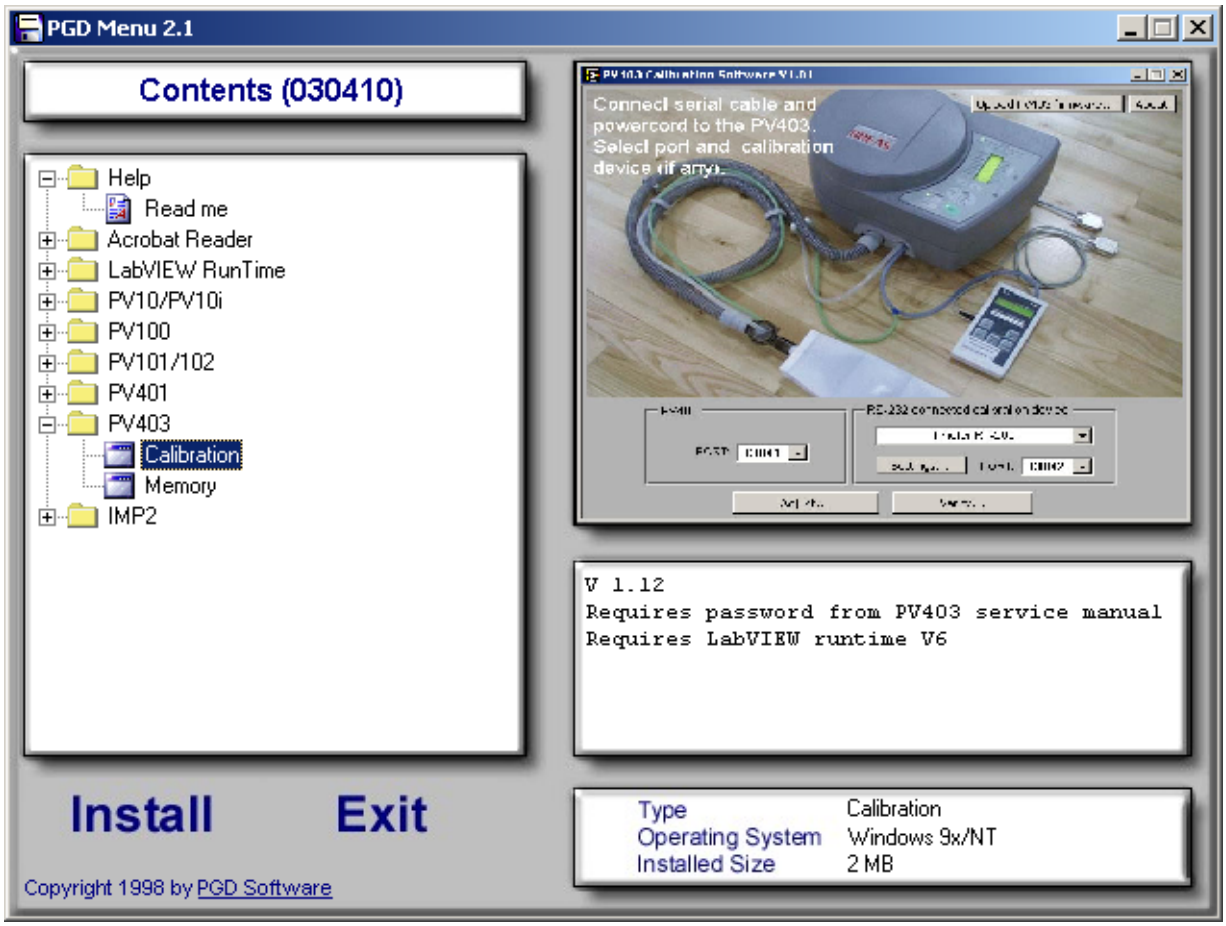


Fig. 7-b Installing the calibration software

7.2 Starting the calibration

After a calibration or upgrade, always check the patient settings of the ventilator.

7.2.1 Requirements

Follow the requirements below when calibrating the pressure sensor:

- Let the ventilator run for approximately 30 minutes before you start the calibration. The PV 403 should be at normal working temperature when the calibration is performed.
- Keep the power cord of the PV 403 connected to the mains power during the calibration.

7.2.2 Starting the calibration

1. Connect a patient circuit with a test lung to the PV 403.
2. Connect the pressure reference manometer (manual calibration) or the Thommen digital manometer (manual or automatic calibration) to the PV 403.
3. Connect the PV 403 and, if applicable, the calibration device to the COM ports on the PC as shown in the photograph in the main window (see below).
4. If applicable, start the calibration device.
5. Start the calibration program from the Start menu in Windows by selecting **Programs** > **BreasMedical** > **PV 403 Calibration**.
6. If this is the first time you are using the calibration software, enter the password **54312**. The main window is displayed (see below).

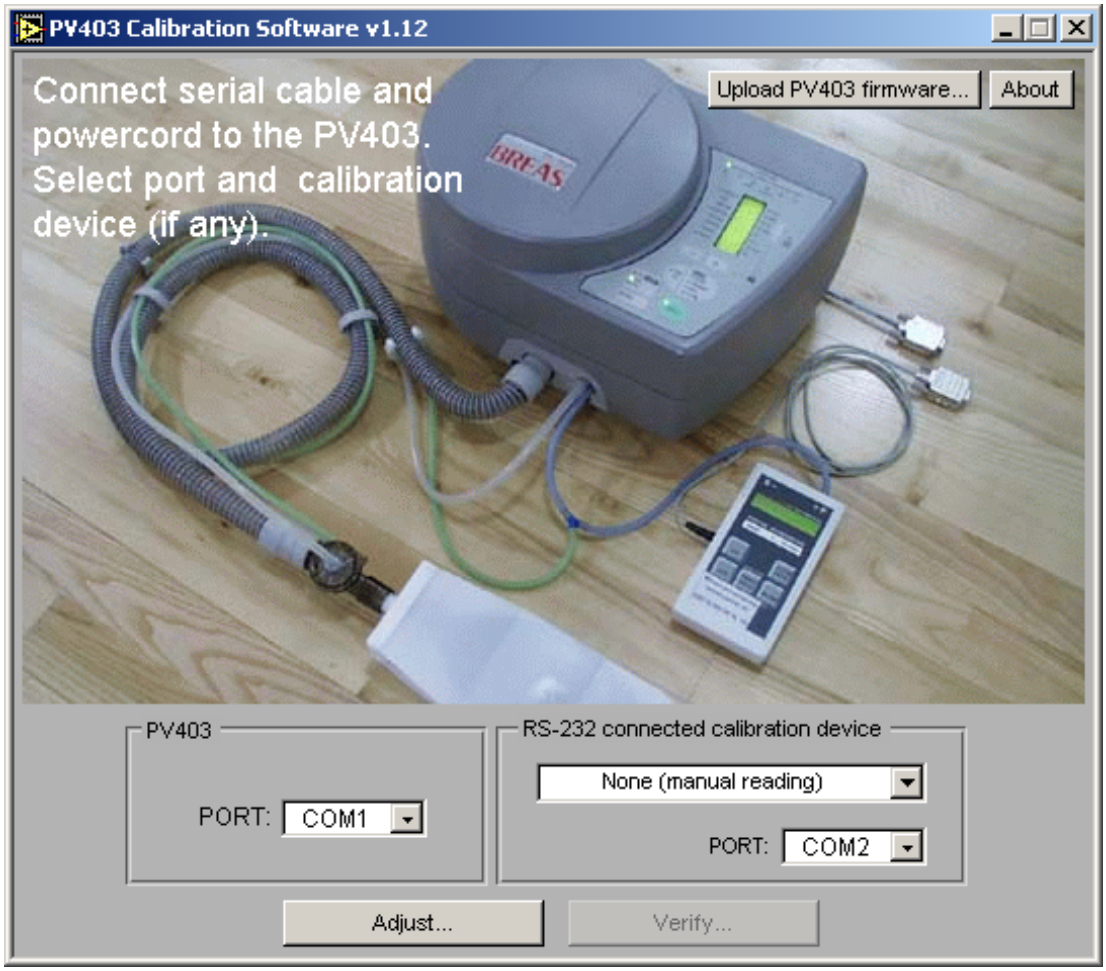


Fig. 7-c PV 403 calibration software main window

7 Select the COM port to be used for the connection between the PC and the PV 403.

8 If applicable, select the COM port to be used for the connection to the calibration device.
If you select a COM port number that is already in use the program will terminate.

9 Select the type of calibration device to be used or select None (manual calibration).

10 Click the **Adjust** button.
The **Setup** tab of the **Adjust pressure PV 403** window is displayed (see section below).

11 Proceed with manual or automatic adjustment (see following sections).

7.2.3 Adjust pressure PV 403 window

The **Adjust pressure PV 403** window is displayed below.

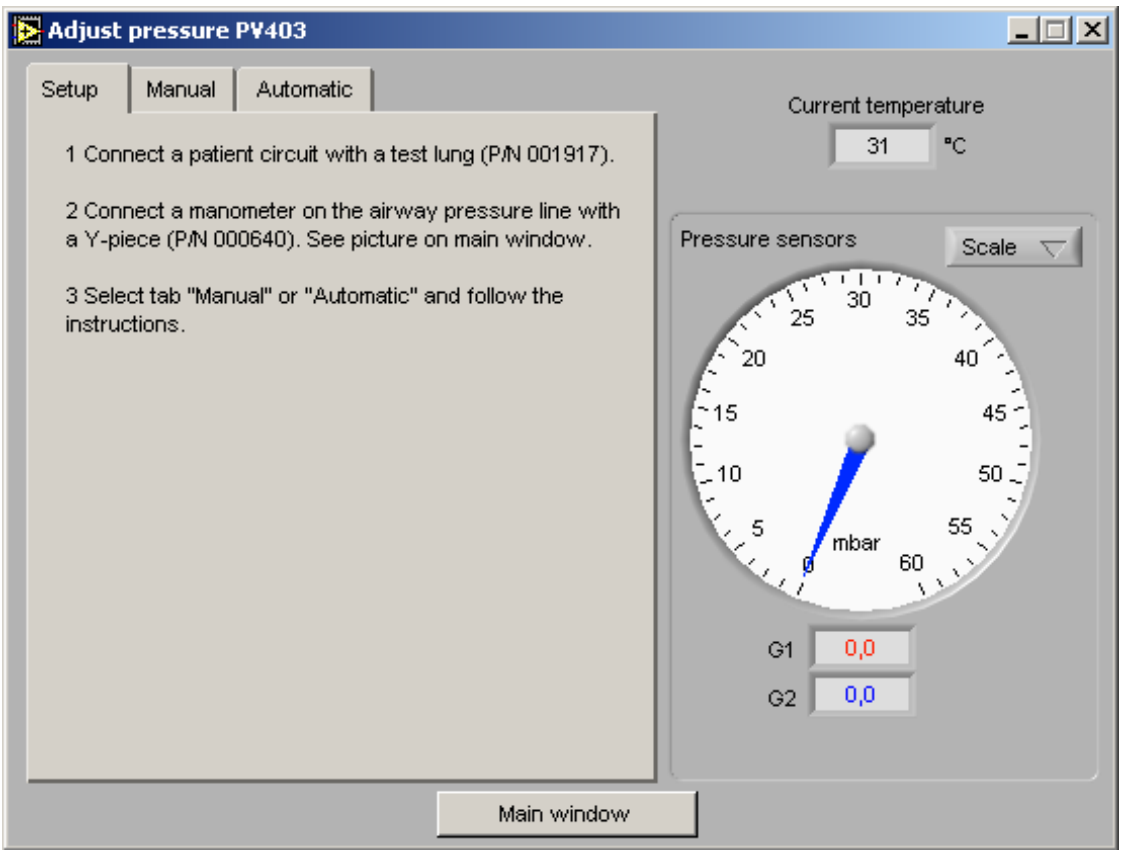


Fig. 7-d Adjust pressure PV 403 window – Setup tab

The **Adjust pressure PV 403** window consists of the following items:

Window items	Description
Setup tab	Used for displaying the initial calibration instructions
Manual tab	Used for manually adjusting the PV 403. Includes user controls for the G1 and G2 pressure sensors.
Automatic tab	Used for automatically adjusting the PV 403
Current temperature field	Used for displaying the actual working temperature of the PV 403
Pressure indicator panel	Pressure meter and fields used for displaying the measured values of the G1 sensor (red), the G2 sensor (blue), and the manometer (black)
Scale button	Used for changing the display of the pressure meter. The following options can be selected from the drop-down list: • 0–60 mbar • 35–45 mbar (for detailed display of the 40 mbar pressure range)
Main window button	Used for saving the settings and returning to the main window

7.3 Manual adjustment

Manual adjustment is done with a pressure reference manometer connected to the PV 403. You begin by adjusting the G2 pressure sensor for 6 mbar and 40 mbar and continue by adjusting the G1 sensor for the same pressure values.

7.3.1 Starting the manual adjustment

1. Start the PV 403 calibration software (see section 7.2).
2. Select the **Manual** tab from the **Adjust pressure PV 403** window.

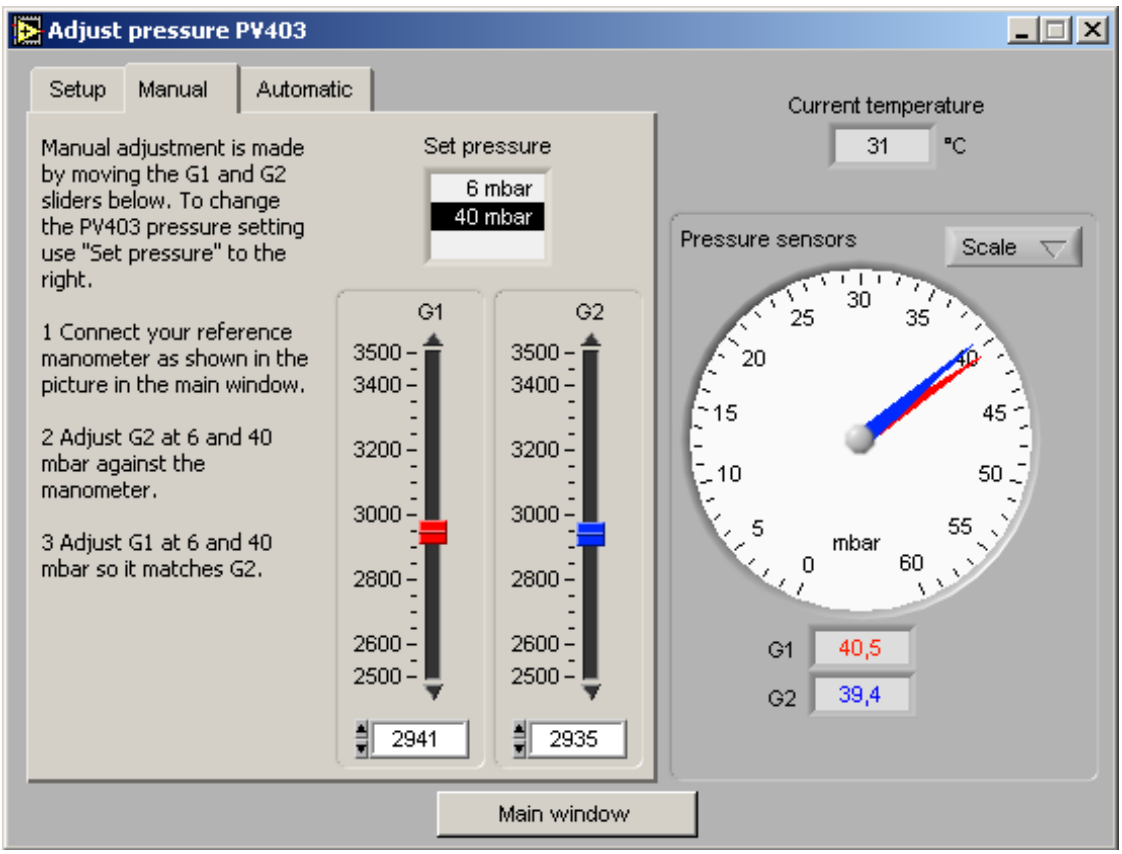


Fig. 7-e Adjust pressure PV 403 window – Manual tab

You can view a detailed display of the 40 mbar pressure range by selecting it from the **Scale** drop-down list.

7.3.2 Adjusting the G2 pressure sensor

1 Set the settings parameters of the ventilator as follows:

Pressure	6 mbar
Rate	6 BPM
Insp. time	5.0 seconds
Plateau	9
Mode	PCV

The pressure 6 mbar is selected in the **Set pressure** field.

2 Make sure that the G2 pressure displayed on screen at each breath stabilises at 6 mbar ±1 mbar. If not, use the slider or the field below to adjust the G2 settings on screen.

3 Change the pressure in the **Set pressure** field to 40 mbar.

4 Make sure that the G2 pressure displayed stabilises at 40 mbar ±1 mbar. If not, adjust the G2 settings.

7.3.3 Adjusting the G1 pressure sensor

1 Set the settings parameters of the ventilator as follows:

Pressure	6 mbar
Rate	6 BPM
Insp. time	5.0 seconds
Plateau	9
Mode	PCV

The pressure 6 mbar is now selected in the **Set pressure** field.

2 Make sure that the G1 pressure displayed on the pressure gauge of the ventilator stabilises at 6 mbar ±1 mbar. If not, use the slider or the field below to adjust the G1 settings on screen.

3 Change the pressure in the **Set pressure** field to 40 mbar.

4 Make sure that the G1 pressure displayed on the pressure gauge stabilises at 40 mbar ±1 mbar. If not, adjust the G1 settings on screen.

After adjustment proceed with section 7.3.4.

7.3.4 Verifying the calibration of the pressure sensors

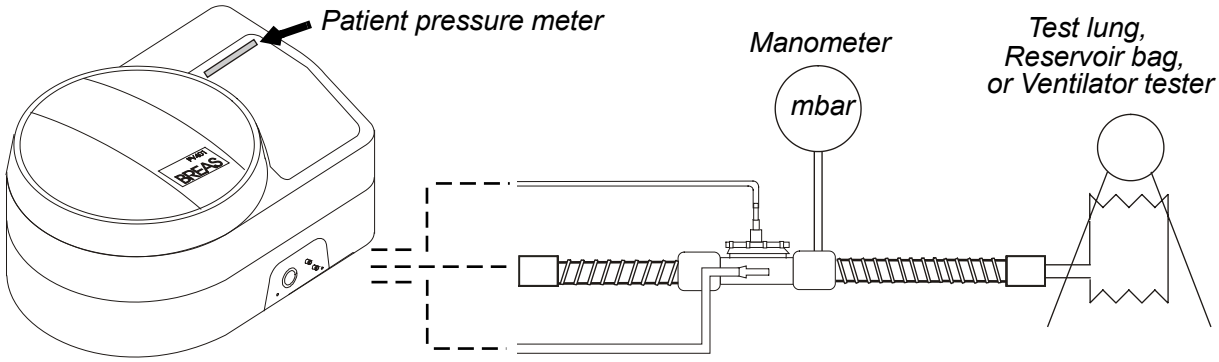


Fig. 7-f The verifying process

1 Connect the manometer to the air outlet of the PV 403.

2 Start the ventilator.

3 Set the settings parameters of the ventilator as follows:

Pressure	6 mbar
Rate	6 BPM
Insp. time	5.0 seconds
Plateau	9
Mode	PCV

4 Check that the pressure on the manometer is 6 mbar.
The pressure should be within the tolerance range of ±1 mbar.

5 Check that the pressure on the patient pressure meter is 6 mbar.
The pressure should be within the tolerance range of ±1 mbar.

6 Repeat this procedure for 10, 15, 20, 30, 40, and 50 mbar until all the levels are checked.
If any pressure is incorrect you must perform a calibration with the PV 403 calibration software.

Set pressure (mbar)	Measured on manometer (G2)	Displayed on patient pressure meter (G1)
6		
10		
15		
20		
30		
40		
50		

Fig. 7-g Example of a table for verifying manual adjustment.

7.4 Automatic adjustment

A Thommen calibration device can be used to automate the entire calibration process.

7.4.1 Starting the automatic adjustment

1 Start the PV 403 calibration software (see section 7.2).

2 Select the **Automatic** tab from the **Adjust pressure PV 403** window.

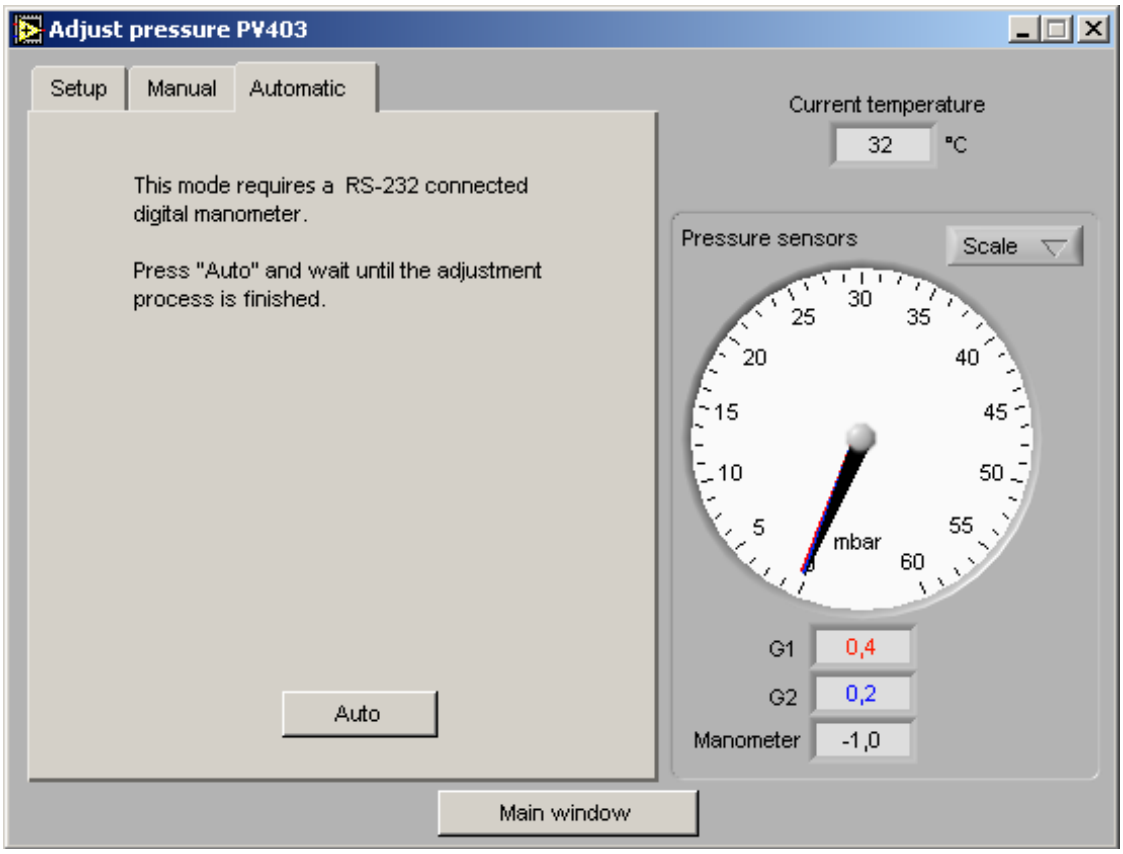


Fig. 7-h Adjust pressure PV 403 window – Automatic tab

3 Click the **Auto** button.
You will be able to follow the entire calibration process on screen.

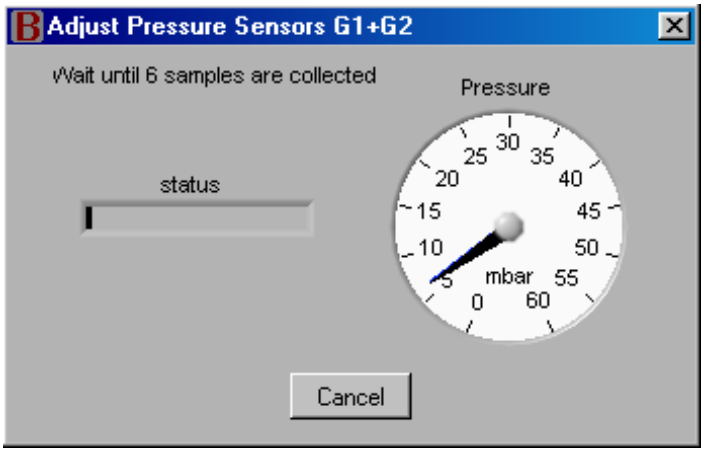


Fig. 7-i Adjust Pressure Sensors window

After the adjustment is completed the message **"Adjustment successful"** is displayed.

7.4.2 Verifying the automatic adjustment

1. Click the **Verify** button in the main window.
   The **Verify pressure PV 403** window is displayed.
2. Click the **Start** button to start the verification process.
   You will be able to follow the verification of all the set pressure values in the **Verified pressures** fields.

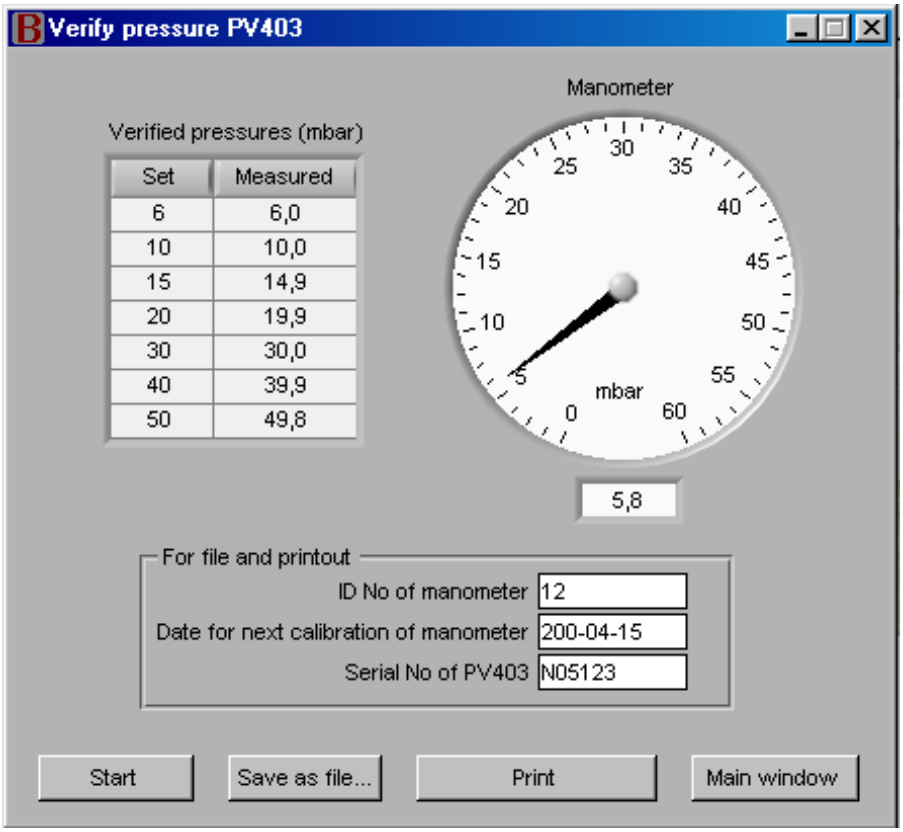


Fig. 7-j Verify pressure PV 403 window

After a successful verification all the filled-in **Measured** fields have white backgrounds. If any field has a red background a new adjustment must be performed.

3. If you want to save or print the information about the calibration you can enter the ID number and the next calibration date of the manometer in the applicable fields.
4. Check the serial number that is automatically displayed in the **Serial No of PV 403** field.
5. Click the **Save as file...** button to save the calibration values as a text file.
6. Click the **Print** button to print out the calibration values.
7. Click the **Main window** button to return to the main window.

7.5 Upgrading the PV 403 firmware

Be sure that the firmware you choose to upload is compatible with the PV 403 hardware revision. If in doubt contact BREAS technical support.

After a calibration or upgrade, always check the patient settings of the ventilator.

7.5.1 Starting the upgrade

1. Connect the PV 403 to the COM port on the PC as shown in the photograph in the main window (see below).
2. Start the calibration program from the Start menu in Windows by selecting **Programs** > **BreasMedical** > **PV 403 Calibration**.
3. If this is the first time you are using the calibration device, enter the password **54312**. The main window is displayed (see below).
4. Click the **Upload PV 403 firmware** button in the main window.

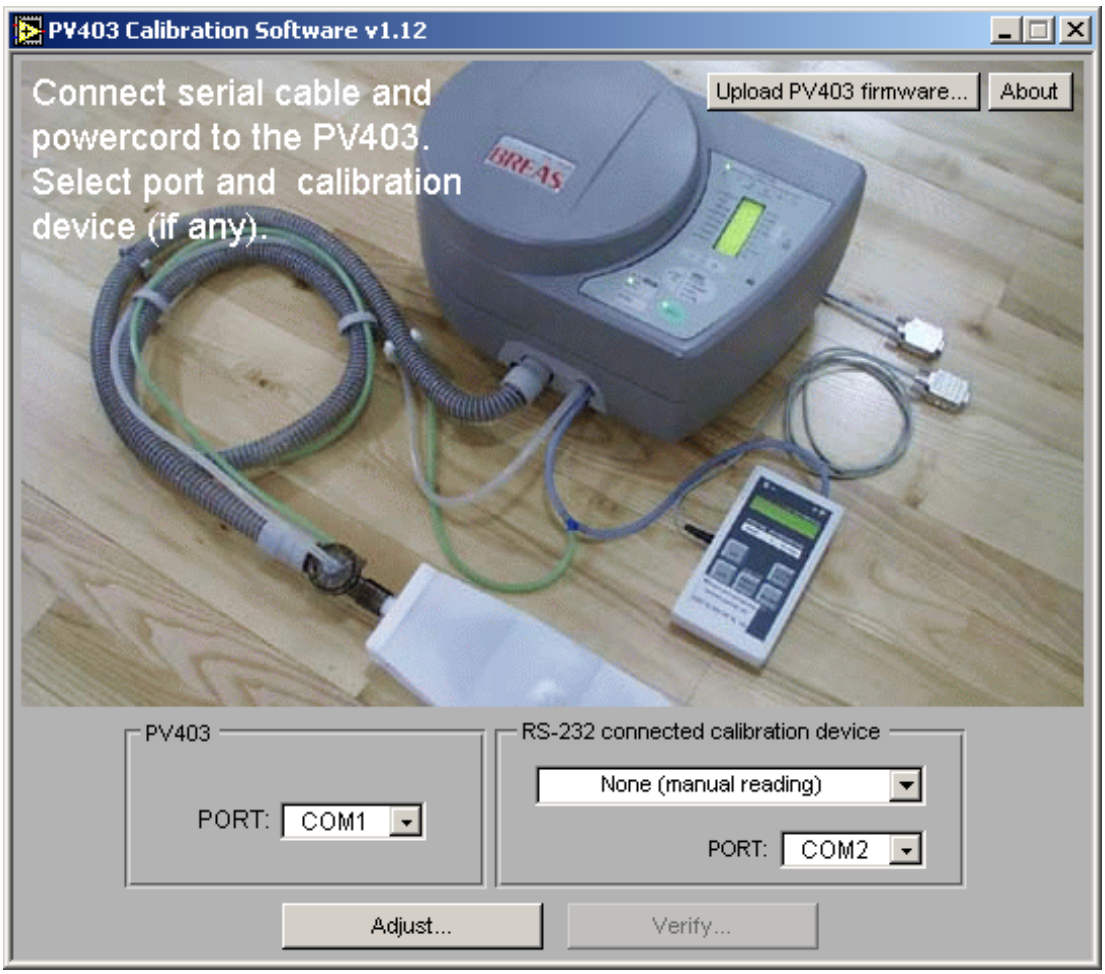


Fig. 7-k PV 403 calibration software main window

7.5.2 Upgrading the CPU board and alarm board firmware

You can see a list of the present firmware versions in the PV 403, by clicking the **Test** button. The "**List firmware versions**" window is displayed.

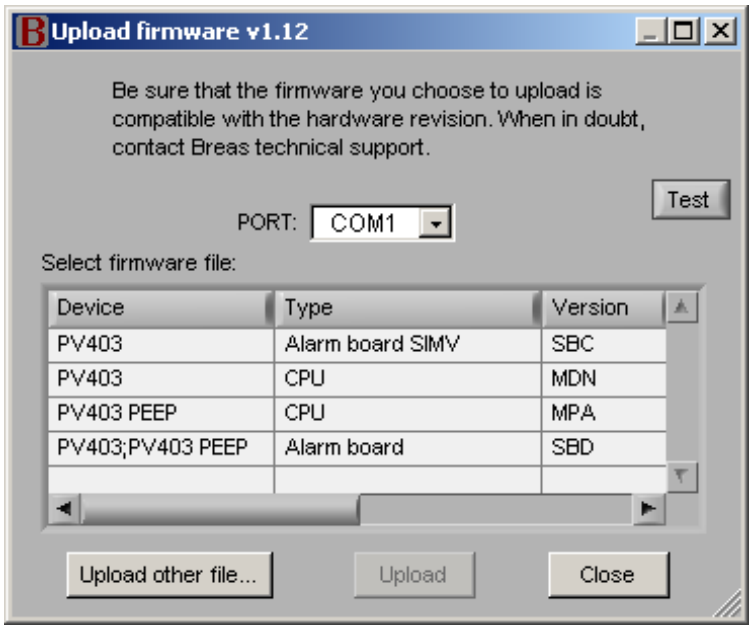


Fig. 7-I Upload firmware

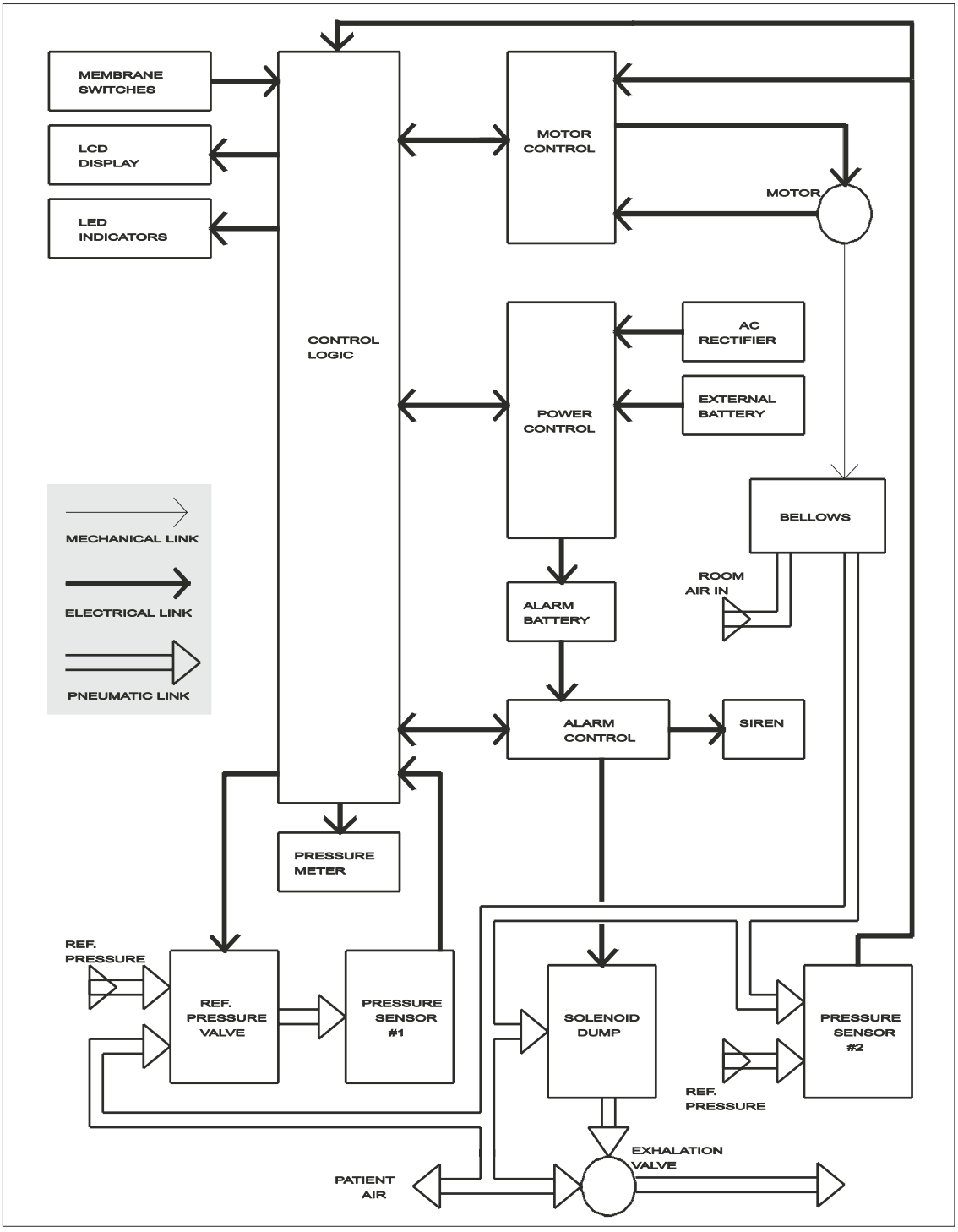
1. Select the COM port to be used for the connection between the PC and the PV 403.
2. Select the upload file in the **Select firmware file** field and click the **Upload** button. The upgrading program performs a check to verify if the PV 403 is connected to mains voltage. Follow the on-screen instructions if the window "**Connect to mains voltage**" is displayed.
3. If you want to select another file that is not located in the PV 403 Calibration folder, click the **Upload other file...** button.
   After the upload is completed the message "**Firmware upload successful**" is displayed.
4. Close the window.

8 Electronics

The electronics, optics, mechanics, and pneumatics of the PV 403 are integrated. To understand fully the electronics of the PV 403, you must know how to use the ventilator, study the air flow diagram and acquaint yourself with the mechanical construction.

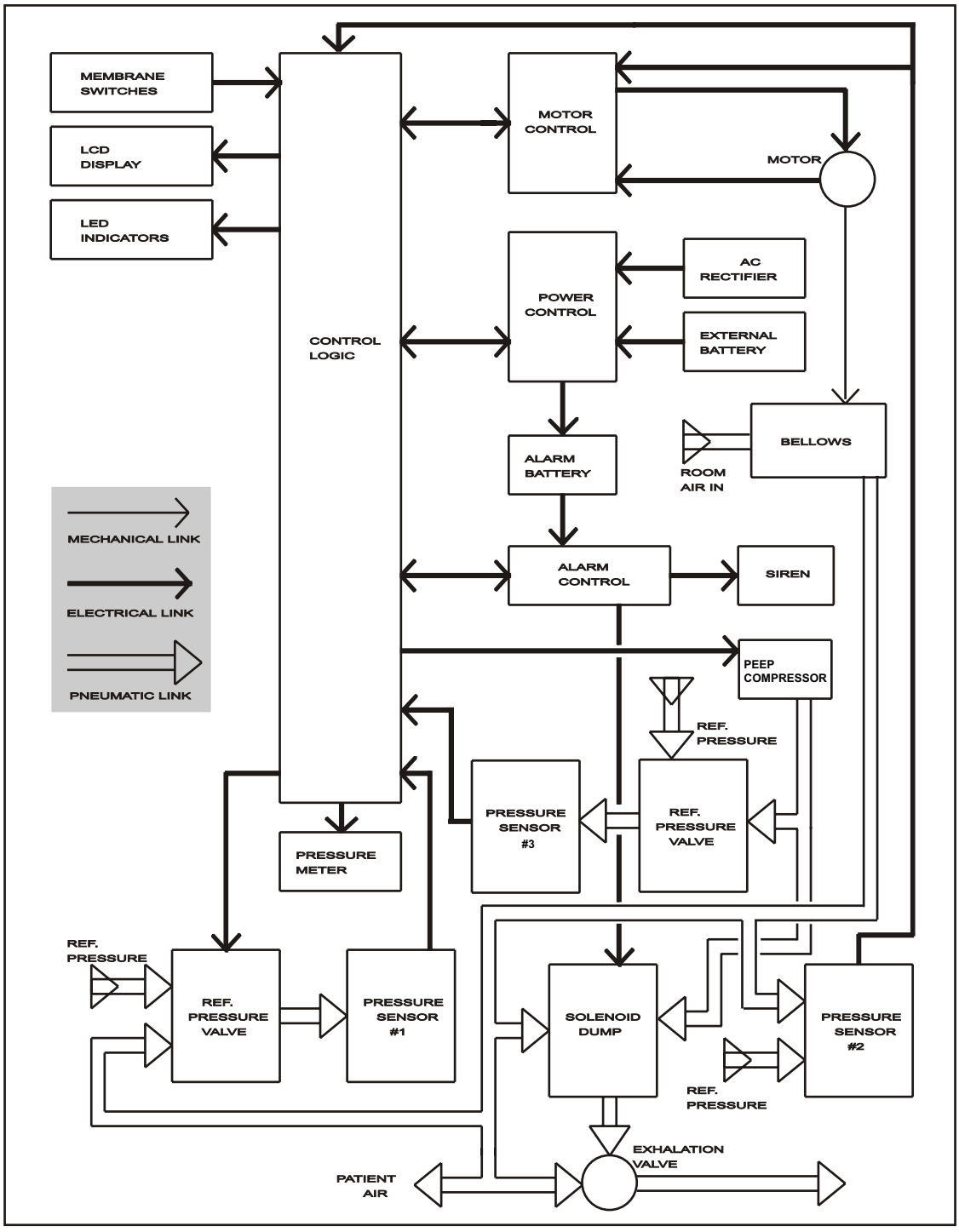
8.1 Functional block diagram PV 403

The functional block diagram below shows how the electronics are arranged and how they are connected to the other main components of the ventilator.



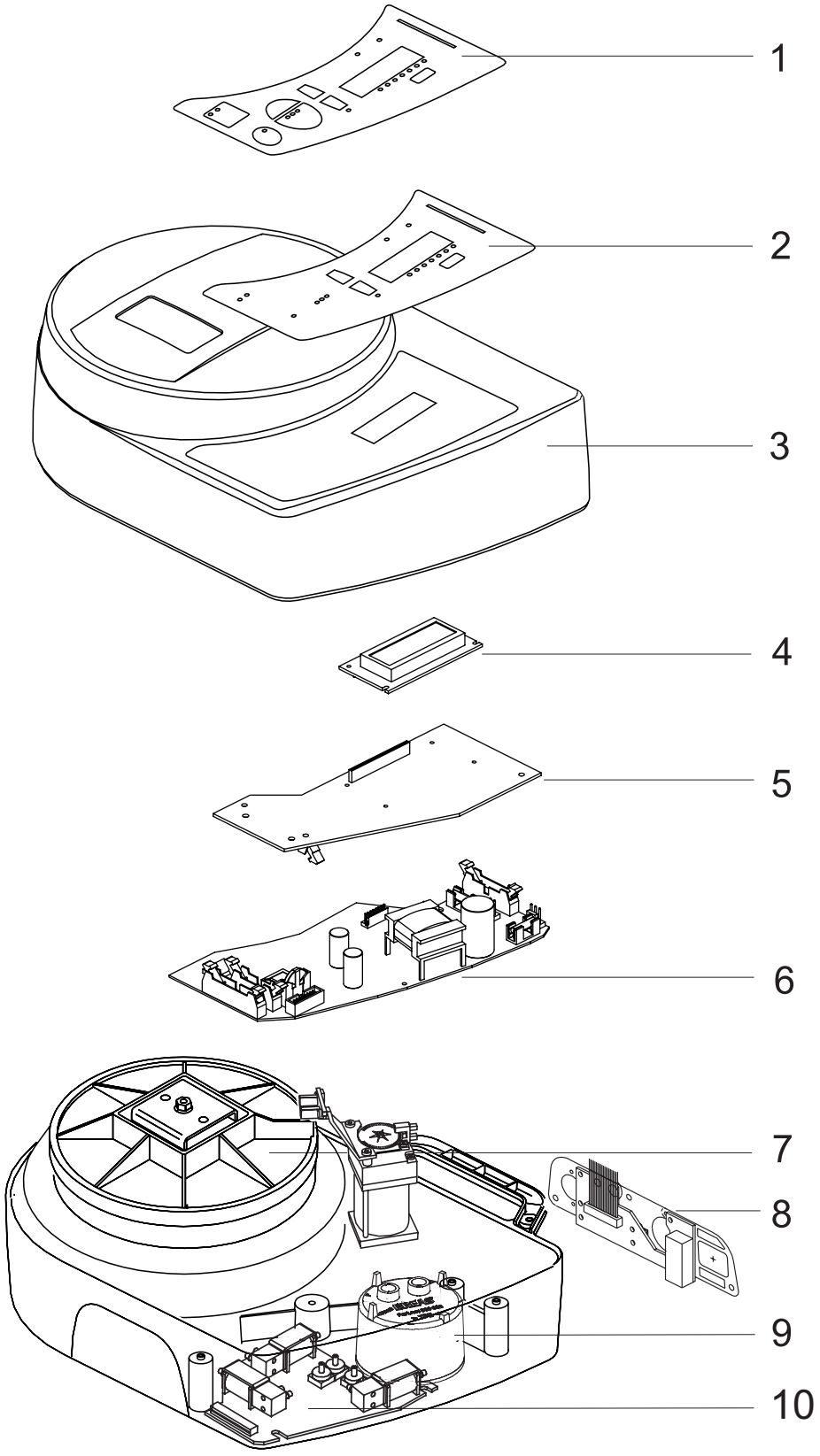
8.2 Functional block diagram PV 403 PEEP

The functional block diagram below shows how the electronics are arranged and how they are connected to the other main components of the ventilator.



8.3 Main components

The electronics of the PV 403 consists of the circuit boards, the optoswitches that control the motor assembly, a push-button membrane panel, and a transformer.

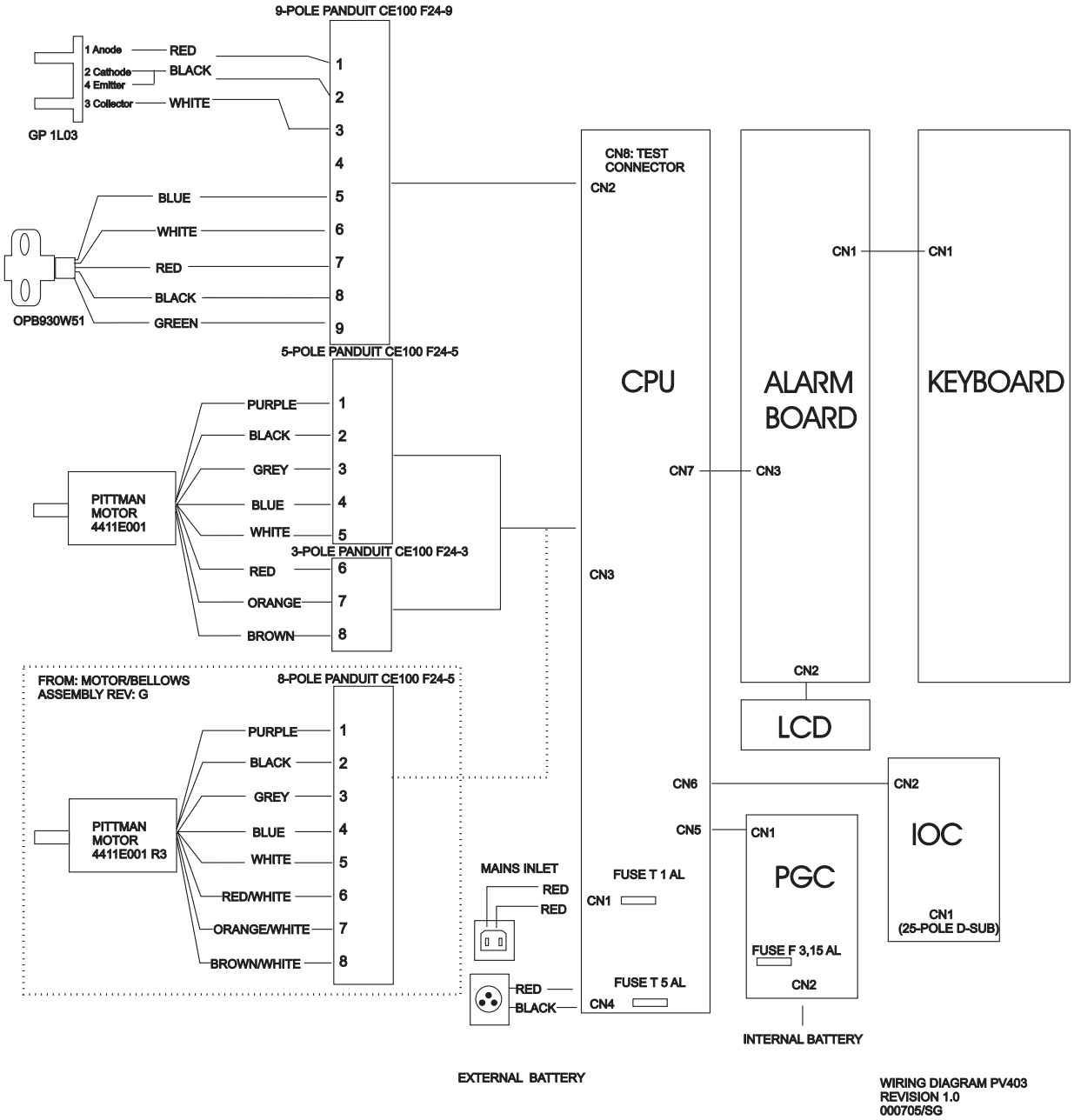


The table below lists the main components of the PV 403.

No.	Description
1	Panel label
2	Membrane push-button pad
3	Upper casing
4	LCD display
5	Alarm board
6	CPU board
7	Motor assembly, complete
8	I/O (Input/Output) board
9	PEEP compressor (only in PV 403 PEEP)
10	PGC (Pressure Gauge Card) board

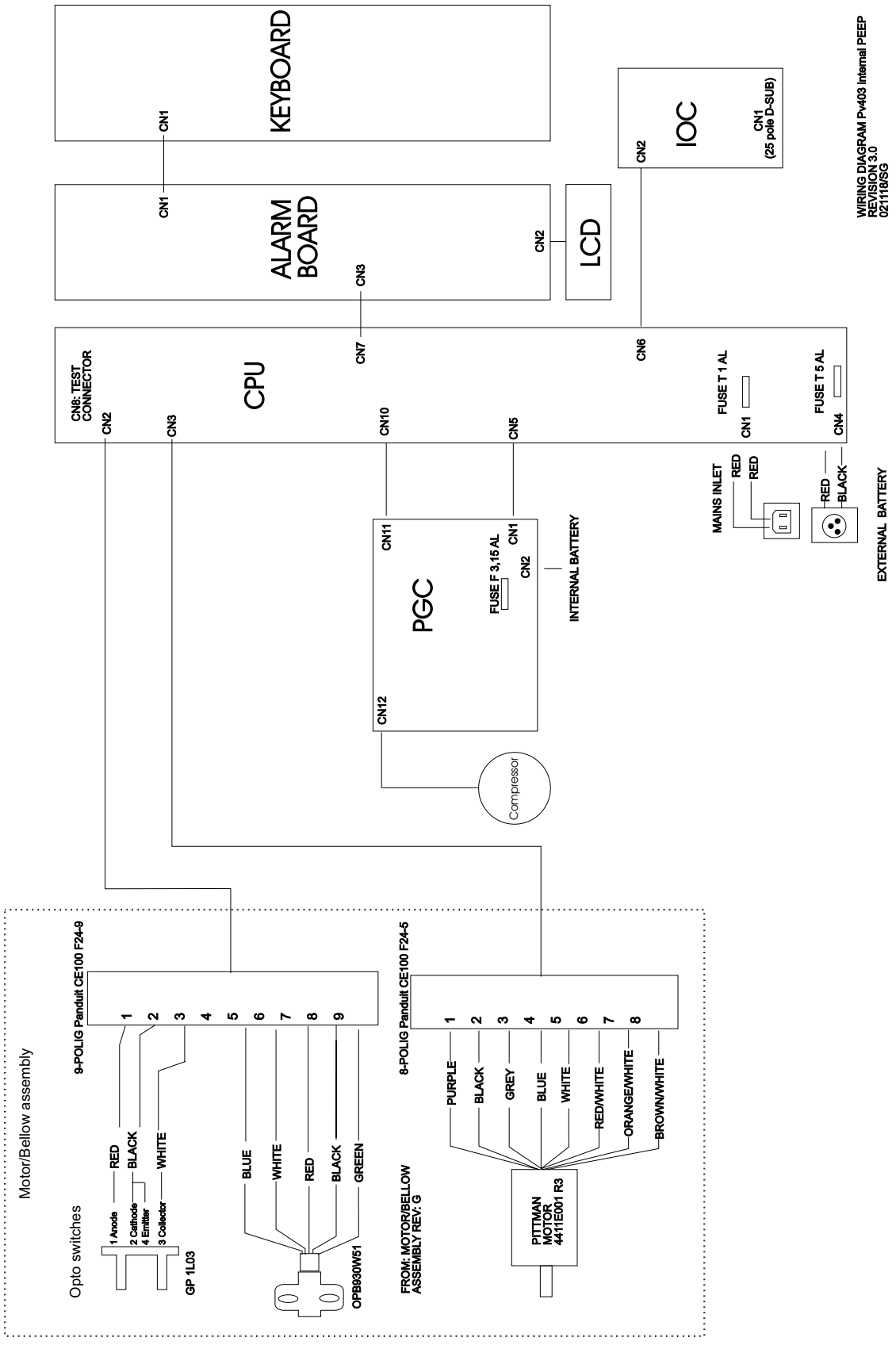
8.4 Main cabling diagram PV 403

The diagram below illustrates the main cabling of the PV 403.



8.5 Main cabling diagram PV 403 PEEP

The diagram below illustrates the main cabling of the PV 403 PEEP.



8.6 Circuit board descriptions

This section contains descriptions and figures of the circuit boards, the LCD display, and the push-button membrane panel of the PV 403.

The circuit boards of the PV 403 are the alarm board, the CPU board, the PGC (Pressure Gauge Card) board, and the I/O (Input/Output) board.

8.6.1 Push-button membrane panel

The push-button membrane panel includes all the push-buttons, indicator LEDs, and the pressure bar indicator.

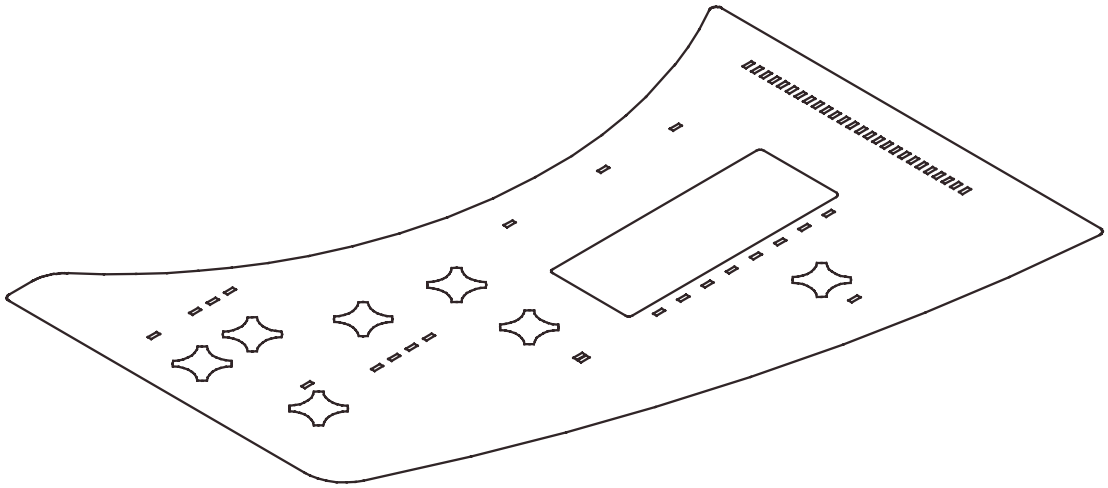


Fig. 8-a Push-button membrane panel

8.6.2 LCD display

The LCD display is fitted to the alarm board. The contrast of the display is automatically adjusted by the temperature sensor (TS1 or TS2) located on the alarm board.

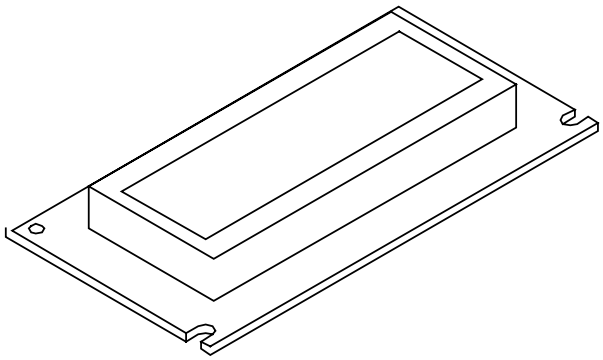


Fig. 8-b LCD display

8.6.3 Alarm board

The alarm board contains the LCD display, the U1 microprocessor, and the circuits that control the LEDs of the push-button membrane panel.

The U1 processor runs the LCD display and the LEDs and controls the push-button membrane panel. It also supervises the communication to the CPU board and issues alerts if this communication is broken. When the ventilator is turned off the U1 processor runs in so-called sleep mode with low consumption of power.

If the power fails or if any internal error occurs that affects the power supply to the ventilator, the BAT1 battery (NiMH) will run the U1 processor, enabling an audible alarm to sound and the red Power LED to be lit.

A temperature sensor (TS1 or TS2) automatically adjusts the contrast of the LCD display.

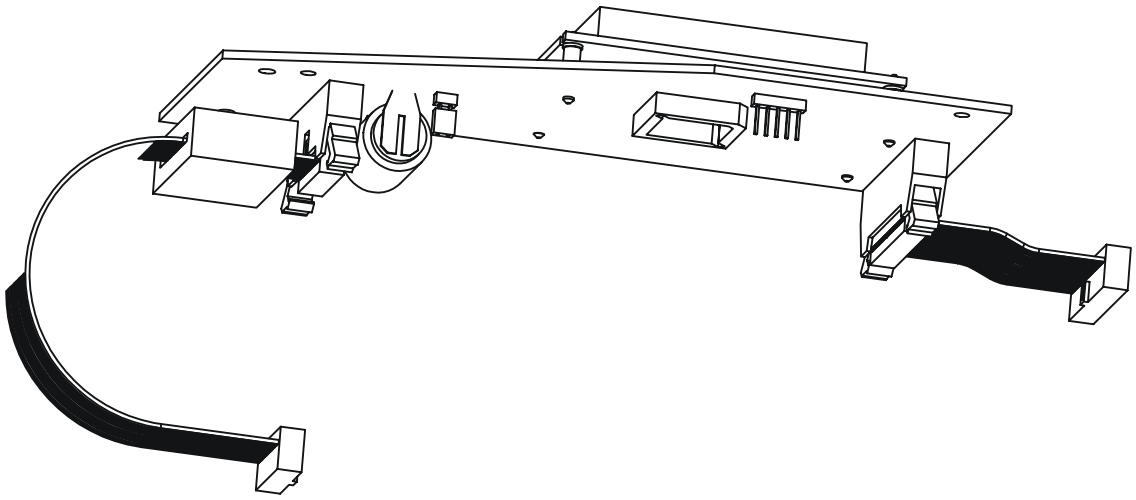


Fig. 8-c Alarm board

8.6.4 CPU board

The CPU board has three main functions: the power supply, the motor drive circuit, and the microprocessor (master processor).

The program of the U8 master processor is stored in the U7 PROM.

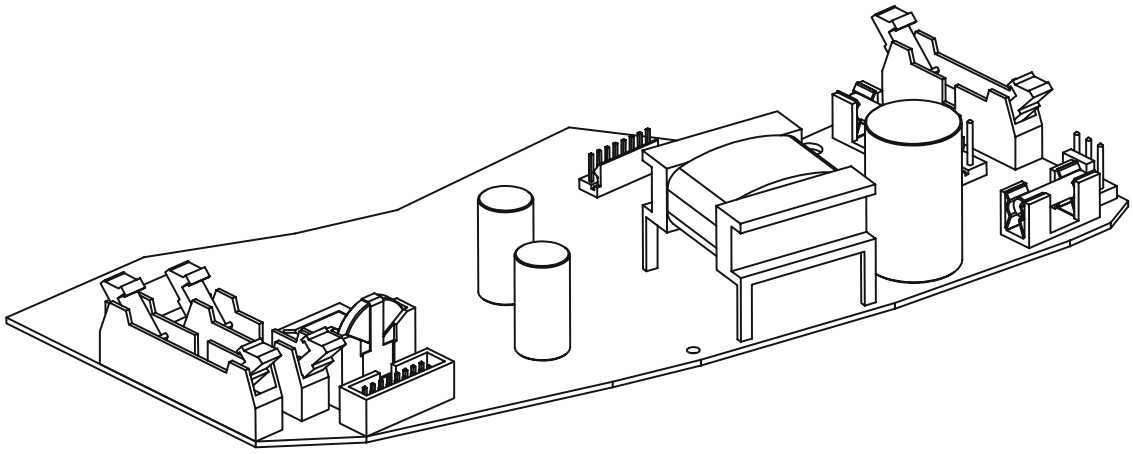


Fig. 8-d CPU board

The U8 processor

The U8 processor serves as a sensor for the push-buttons and stores all the settings in the U6 PROM. The settings are displayed on the LCD display by the microprocessor on the alarm board.

The U8 processor also controls all the alarm functions of the ventilator, for example, the high- and low-pressure alarms, the high- and low-tidal volume alarms, and the low-battery voltage alarm.

The U8 processor controls the motor by using, among other components, the transistors Q2, Q3, Q4 (motor coil 1), etc., the motor encoder, and the pressure sensors on the PGC board, and by measuring the motor current through R35.

The motor optical sensor registers the home position of the moving bellows end cover.

The optical sensor counts the number of pulses from the encoder disc of the motor shaft, and calculates the number of motor revolutions and the movement of the bellow. The tidal volume shown on the LCD display is calculated based on the pulse number that is registered after each patient breath.

The U8 processor starts running as soon as the PV 403 is connected to the mains, even if the ventilator is switched off, thereby enabling the processor to control the battery charging. Moreover, the communication via RS232 works with the ventilator being switched off and connected to the mains.

Power supply components

The power supply components consist of one switch-mode power supply for 100–240V AC, one DC input for the 12 or 24V DC battery supply, one 24V DC input for the internal battery, and one DC–DC converter.

The mains current is led in at CN1, rectified at BR1, and pulse-modified at TR2 and Q7.

After TR2, the current is rectified via D15. The voltage at TP1 should be approximately 30V DC.

The U8 processor measures all the input voltages (mains, external battery, internal battery) and selects the proper power supply by opening Q12, Q13, or Q21. The voltage that the processor selects is labelled +U. The internal converter (consisting of Q15, L3, and Q10, etc.) adjusts the +U voltage to 23.6 V = +VM.

Ventilator switch-on

The following occurs when you switch on the ventilator:

The U1 processor on the alarm board registers the On/Off button being pressed. The processor starts and sends a command after 2 seconds to the U8 processor on the CPU board.

The U8 processor returns a proceed command and the ventilator is switched on. If no mains power is connected to the ventilator when you press the On/Off button the input connectors to the internal and external batteries will open so that the U8 processor will be able to start.

Ventilator switch-off

The following occurs when you switch off the ventilator:

The U1 processor on the alarm board registers the On/Off button being pressed and sends a shutdown command to the U8 processor that saves the necessary data to the non-volatile RAM. The U8 processor then sends a shutdown code to the U1 alarm board processor, which switches off the ventilator.

8.6.5 PGC (Pressure Gauge Card) board

The PGC board contains the two pressure sensors, two magnetic valves, the input connector for the internal battery, and the battery charger.

The G1 pressure sensor supervises and displays the patient pressure. The G2 pressure sensor is used for regulating the pressure in the PCV and PSV modes.

The MV1 magnetic valve is used for the calibration of the zero pressure level of the G1 sensor. When the trigger function of the ventilator is activated the G1 sensor is automatically calibrated between each patient breath. The MV2 magnetic valve works as a safety valve for the high-pressure alarm.

The battery charger uses a current of approximately 350 mA to charge the battery for a maximum of 14 hours non-stop. After 14 hours the charger changes to trickle charging, that is, the charger continues charging the battery for 1 second every minute.

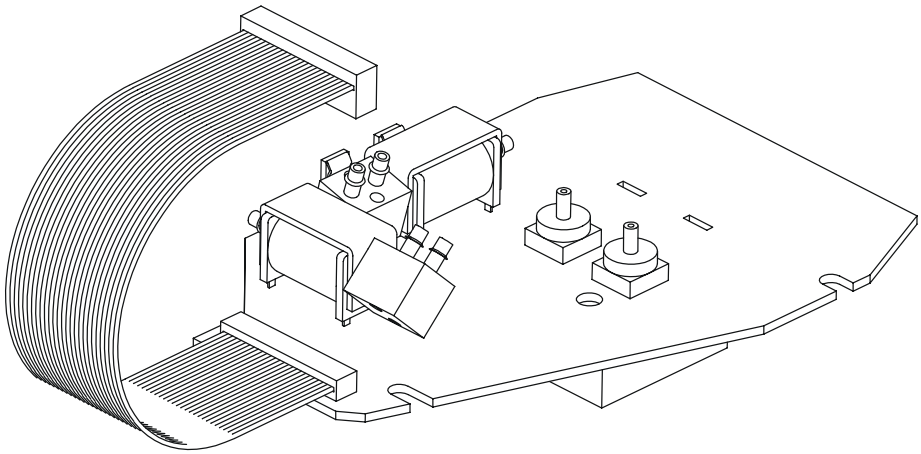


Fig. 8-e PGC board PV 403

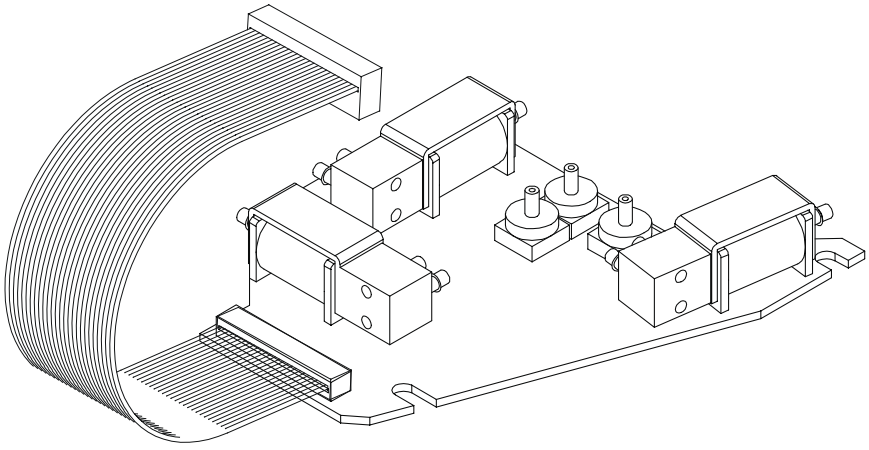


Fig. 8-f PGC board PV 403 PEEP

8.6.6 I/O (Input/Output) board

The I/O board contains the output connector for the external alarm, the alarm buzzer, and the analogue/digital output connectors.

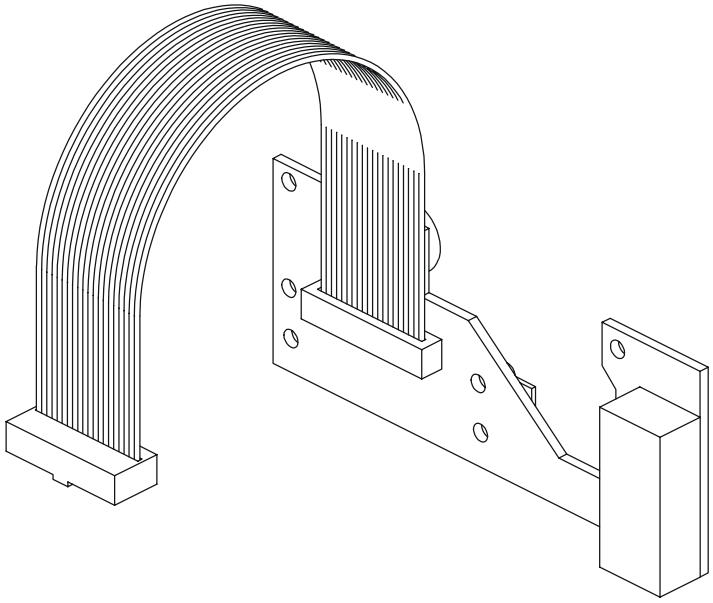


Fig. 8-g I/O board

8.7 Test points – CPU board

8.7.1 Test point locations

The locations of the test points on the CPU board are shown in the figure below.

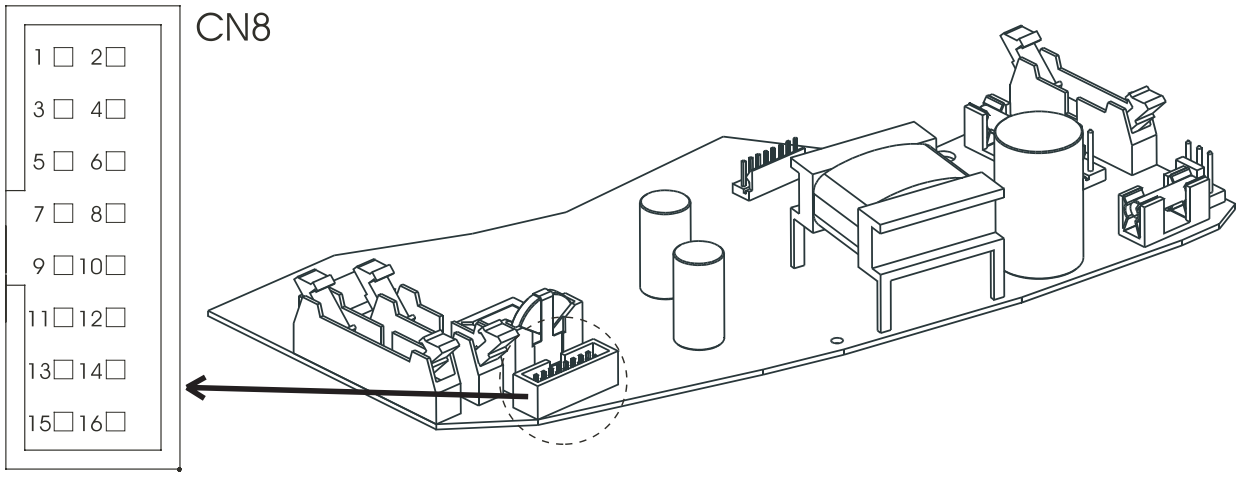


Fig. 8-h Test points on the CPU board

8.7.2 Test point matrix

The following are the test points on the CPU board of the PV 403.

CN8 pin	Voltage	Toler-ance	Description	Power supply	Status
1	28–34 V		PSU_+24	Mains	On or off
2	5 V	±1.0	+LARM_ACK	Mains	On or off
3	30 V	±2.0	INT_BAT	Mains	On or off
4	4.8 or 0.2 V	±0.2	STOP	Mains	On or off (bellow home position)
5	4.8 or 0.2 V	±0.2	ENCOD2	Mains	On or off (motor encoder)
6	0.7 V (at 0 mbar)	±0.2	TRYCK_G1	Mains	Off (gain = 0.07 V/mbar)
7	0.7 V (at 0 mbar)	±0.2	TRYCK_G2	Mains	Off (gain = 0.07 V/mbar)
8	5.0 V	0.05	+VREF	Mains	On or off
9	12 V	0.5	+12 V	Mains	On or off
10	5 V	0.5	+5 V	Mains	On or off
11	11–35 V		+U	Mains or battery	On
12	24 V	±2.0	+VM	Mains	On
13			(P106 airflow)		
14					
16			GND		

8.8 Ventilator switch-over operating voltages

The PV 403 will issue alarm and switch between the various power sources available if any of the conditions described below occur.

8.8.1 AC power supply operation

If a voltage drop occurs while running from an AC power supply the ventilator will react as follows:

- If the mains drops below 80 V AC ±5 V the PV 403 will issue a power-failure alarm or switch over to the external or internal battery, if available.

8.8.2 External battery operation

If a voltage drop occurs while running from an external battery the ventilator will react as follows:

- If the voltage drops below 21.6 V the ventilator will issue a power-failure alarm or switch to the internal battery supply, if available.
- If an internal battery is NOT installed and the external battery voltage drops to 22.7 V the ventilator will issue a low-battery alarm and continue to run until the voltage drops to 21.6 V. The ventilator will then issue a power-failure alarm and switch off.

When the external battery voltage returns to 24 V the ventilator will switch back to the external battery supply.

8.8.3 Internal battery operation

If a voltage drop occurs while running from an internal battery the ventilator will react as follows:

- If the voltage drops to 22.7 V the ventilator will issue a low-battery alarm and continue to run until the voltage drops to 21.6 V. It will then issue a power-failure alarm and switch off.

8.8.4 Measuring the voltages

Measure the voltages as follows:

1. Measure the voltage at the external battery.
2. Measure the internal battery voltage at the test points CN8:3 and CN8:16 GND on the CPU board.

8.9 Checking the internal battery

1. Make sure the battery is fully charged.
2. Set the parameters as follows:

Pressure	40 mbar
Rate	20 BPM
Insp. time	3.0 seconds
Mode	PCV

3. Connect a test lung and start the ventilator.
4. Measure the time it takes for the ventilator to issue an alarm indicating low-battery voltage (approximately 60–90 minutes).
5. Measure the time the ventilator continues running after the low-battery alarm is issued (approximately 5 minutes).

8.10 Checking the external battery

This check can only be performed without the internal battery being installed.

If an internal battery is installed the ventilator will automatically switch to the internal battery supply when the external battery voltage drops too low. In such cases just check that the ventilator switches to the internal battery supply.

To check the operation of the external battery and the low-voltage alarm without an internal battery installed, proceed as follows:

1. Set the following parameters:

Pressure	6 mbar
Rate	8 BPM
Insp. time	3 seconds
Mode	PCV

2. Connect a 1-litre test lung with an exhalation valve.
3. Connect an adjustable DC power supply unit to the external 24 V socket of the ventilator.
4. Set the voltage to 24 V.
5. Switch on the ventilator and make sure the On/Off LED flashes.
   When the external battery voltage drops to 22.7 V (±0.2 V) the low-battery-voltage alarm will start.
   The alarm level must be passed for more than 15 seconds before alarm occurs.
   Lower the voltage by 0,1 Volt steps and wait for moore than 15 seconds between steps.
6. Run the ventilator and slowly reduce the voltage to 21.2 V. Check that a power-failure alarm is issued and that the ventilator switches off.

8.11 Replacing the alarm battery BT1

The alarm battery BT1 is located on the alarm board. The battery must be replaced five years after the delivery date or five years after it was last replaced.

To replace the alarm battery:

1. Disconnect the mains power supply and any external battery.
2. Remove the alarm board. Remove the X3 jumper.
3. Unsolder the two pins for the battery and remove the battery.
4. Remove any remaining solder from the holes.
5. Fit the new battery, checking the polarity, and solder it in place.
6. Fit the alarm board. Put the X3 jumper back.
7. Perform a test start.
   The PV 403 checks the condition of the alarm battery during each start-up cycle. If a fault occurs with the alarm battery, the ventilator will not start, the Power LED will light, and the error message **ALARM BATT. LOW** (error code 19) will be displayed.
8. If this happens after replacing the alarm battery, let the ventilator remain switched off for a few hours but still connected to the mains supply so that the battery is charged.
9. Restart the ventilator.
10. Pull out the power cord while the ventilator is running from the mains supply.
    The red Power LED should light and an audible alarm should be issued. When the power supply is reconnected the ventilator should restart normally.

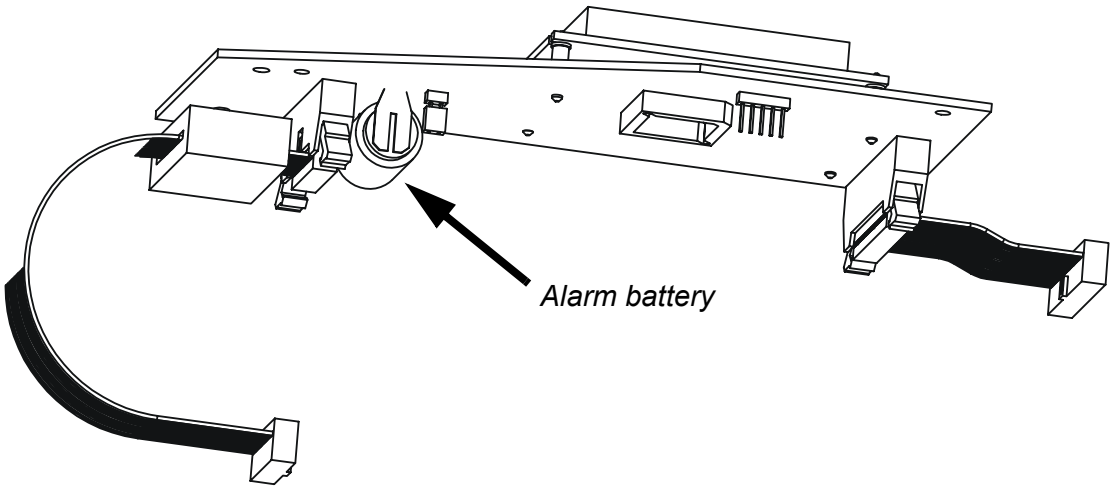


Fig. 8-i Replacing the alarm battery

8.12 Replacing the clock battery

The clock battery is located on the CPU board. The battery must be replaced five years after the delivery date or five years after it was last replaced.

Be careful not to touch areas with mains voltage when the ventilator is connected to the mains power supply.

To replace the clock battery:

1. Keep the mains power cord connected to the mains.
2. On the CPU board, carefully release the battery clamp and pull out the clock battery from its slider.
3. Fit the new clock battery to the slider.

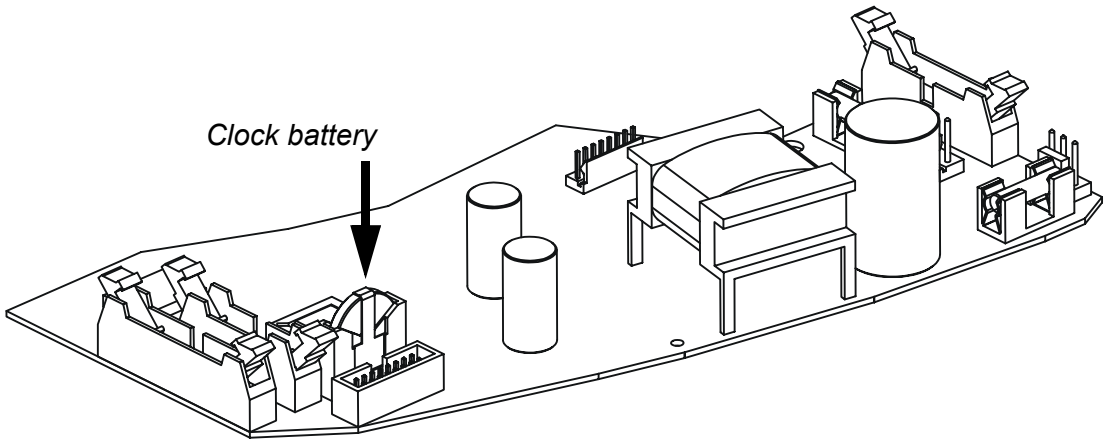


Fig. 8-j Replacing the clock battery

8.13 Setting the date and time

Refer to chapter “Maintenance”, section “Setting the date and time” in the PV 403 Operating Manual.

8.14 Erasing the calendar memory

The calendar memory can only be erased using the Calendar Data Analysis program.

8.15 Electrical safety precautions

Electrical safety measurements must be made in accordance with IEC 601. However, you can make an insulation resistance measurement instead of the voltage test specified by the standard.

Use an automatic electrical safety tester to make the measurements. All tests must be performed in accordance with class II type BF.

8.15.1 Supply voltage

Note the power voltage reading.

The voltage must be noted at each service check, as the currents measured are directly in relation to the supply voltage. This allows all measurements made on the same ventilator to be compared with measurements made on different occasions.

8.15.2 Insulation

The insulation resistance is measured using a 500 V DC power supply. The most suitable method is to connect the plus lead to the two ventilator power socket pins, and the minus lead to the casing or the patient air connector. The measurements made during the delivery inspection can be used as reference values for measurements made during future services. If no reference values are available, the value for the insulation resistance should be >20 M Ω.

8.15.3 Leakage currents

The leakage currents are measured at different parts of the ventilator using an RC circuit to earth.

Make the measurements partly at normal case (NC) and at the single fault condition (SFC). Reverse the polarity of the power supply and note the highest value.

Leakage currents to earth must not exceed the stated limit values.

8.15.4 Leakage currents from the casing

The leakage current of the casing is measured at an unpainted point, for example, the head of a screw.

Limit values: NC <0.1 mA
SFC <0.5 mA

Break neutral for SFC.

8.15.5 Patient leakage currents

The patient leakage current is measured between the patient connector and earth.

Limit values: NC <0.1 mA
SFC <0.5 mA

Break neutral for SFC.

8.15.6 Leakage currents with mains power supply at the patient-connected part

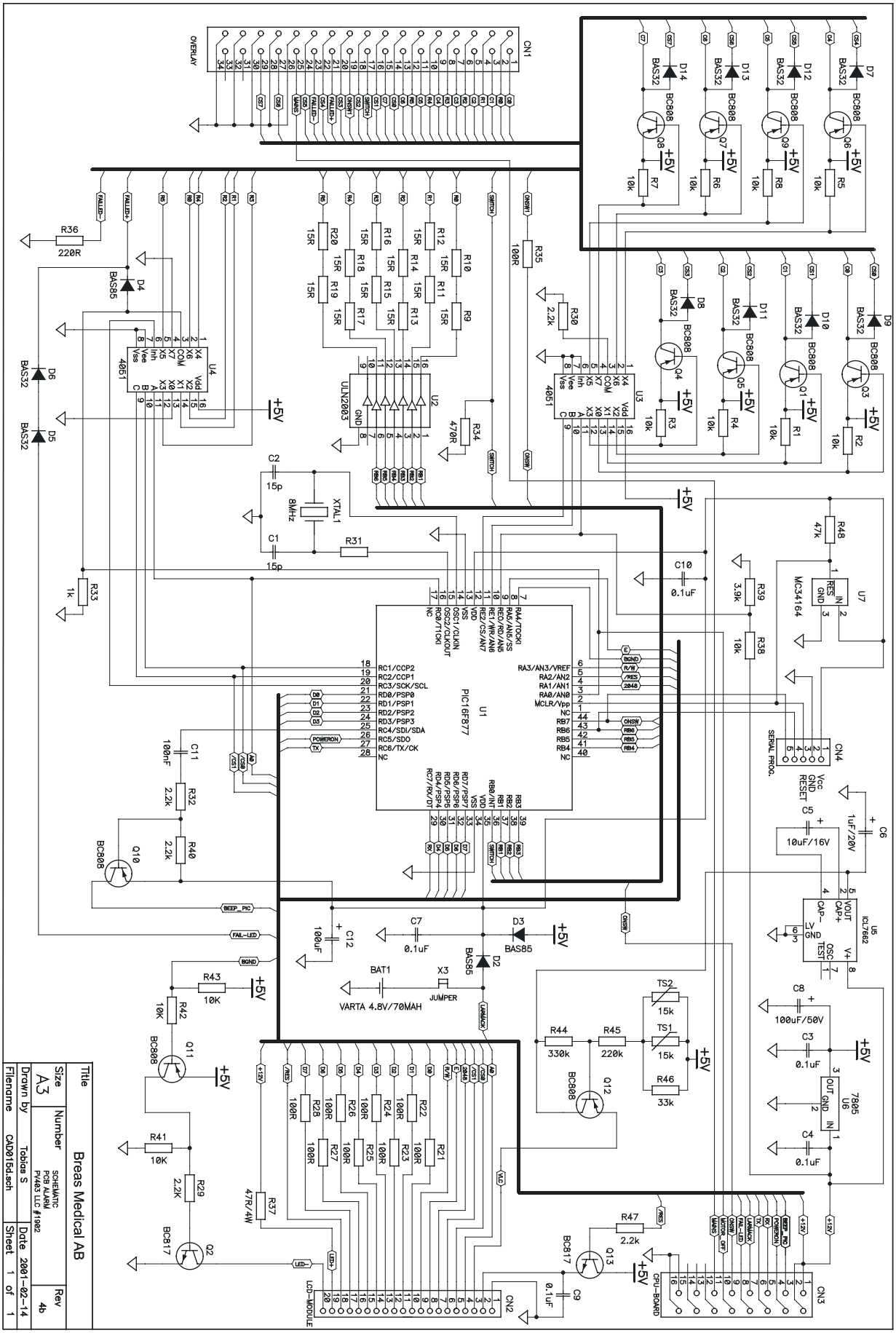
This test must be done using an automatic electrical safety tester with this function. See the safety instructions for the tester.

Limit value: SFC <5 mA

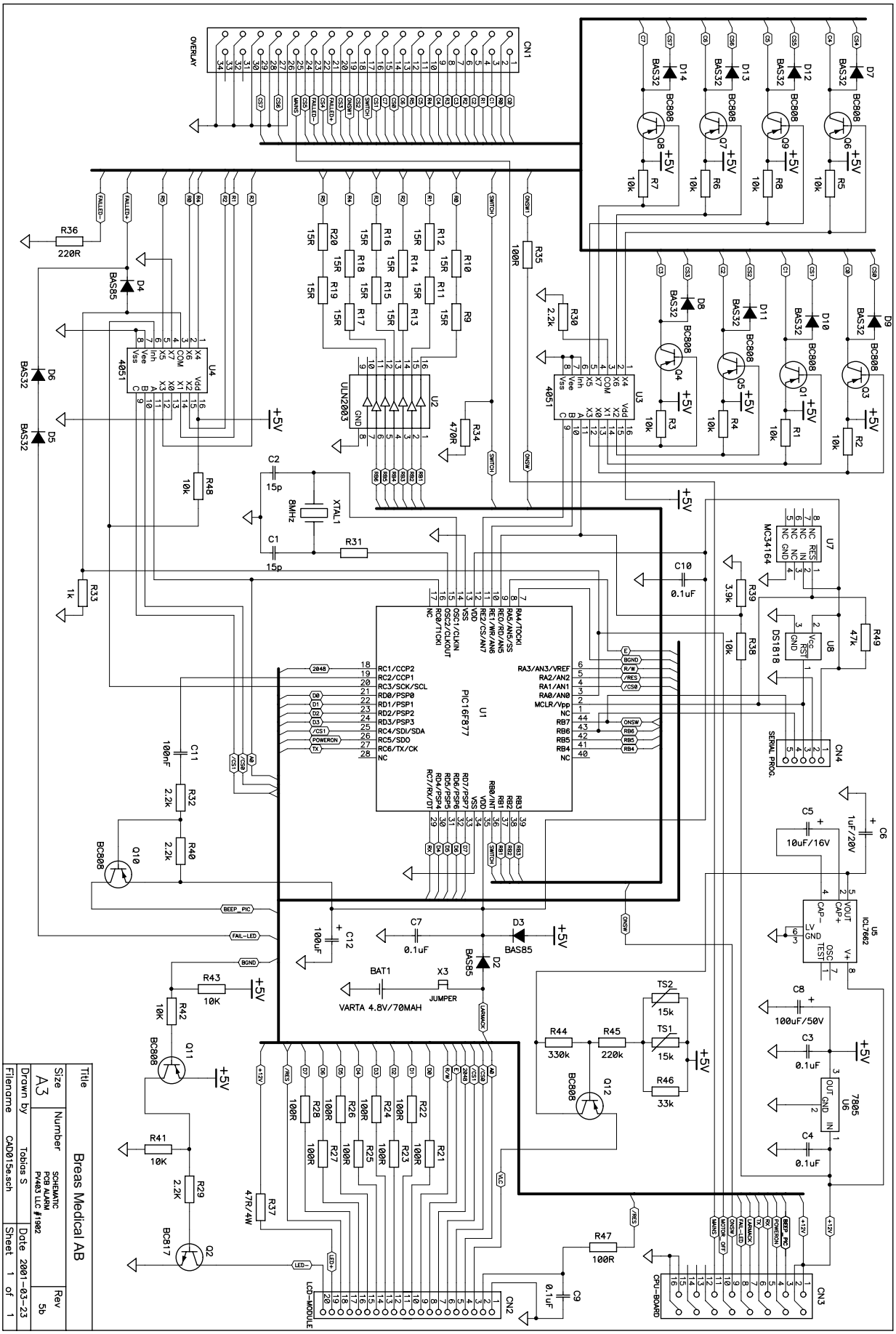
8.16 Circuit diagrams

This section contains the circuit diagrams for the alarm board, the CPU board (5 diagrams), the I/O board, and the PGC board.

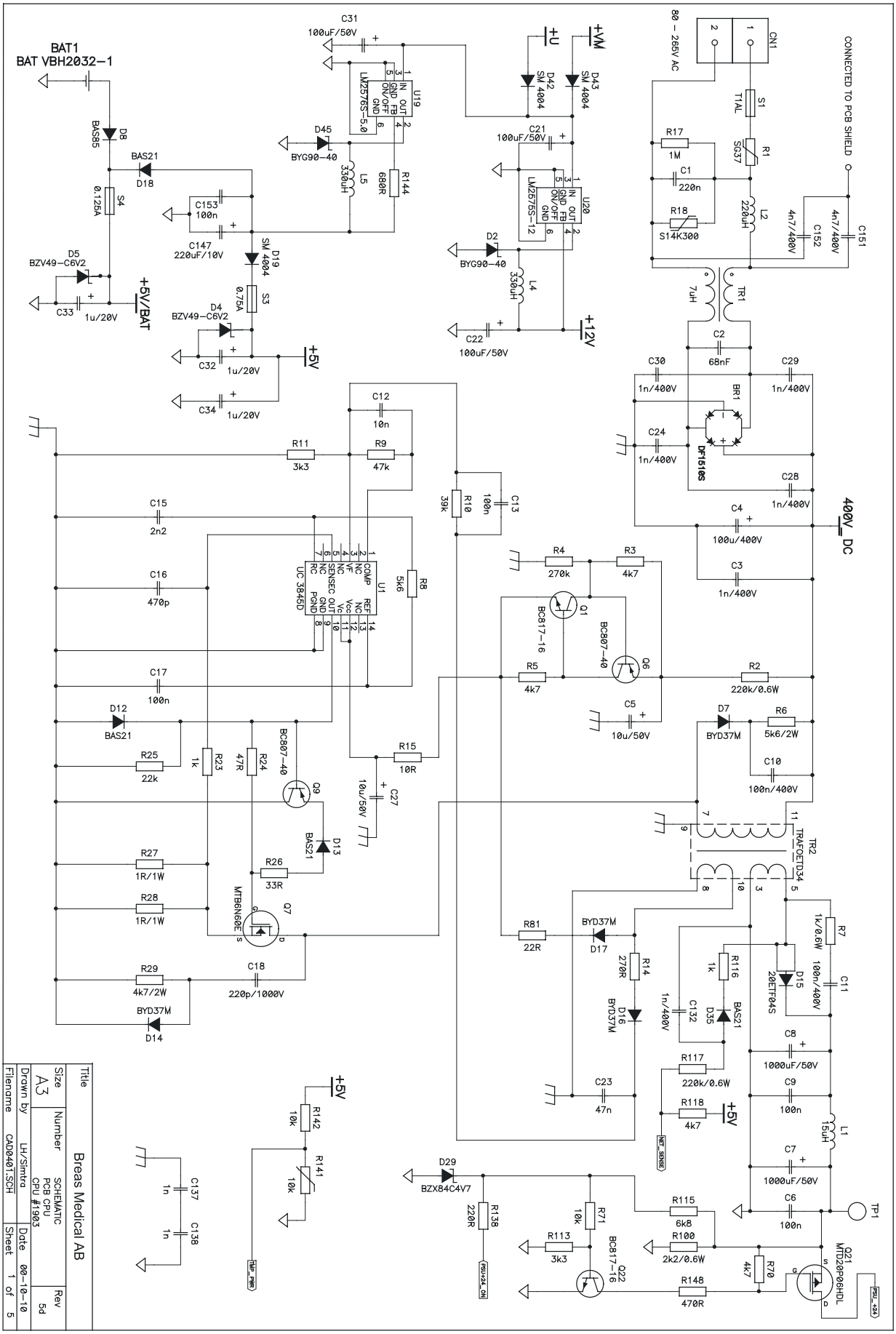
8.16.1 Circuit diagram – Alarm board, rev 4



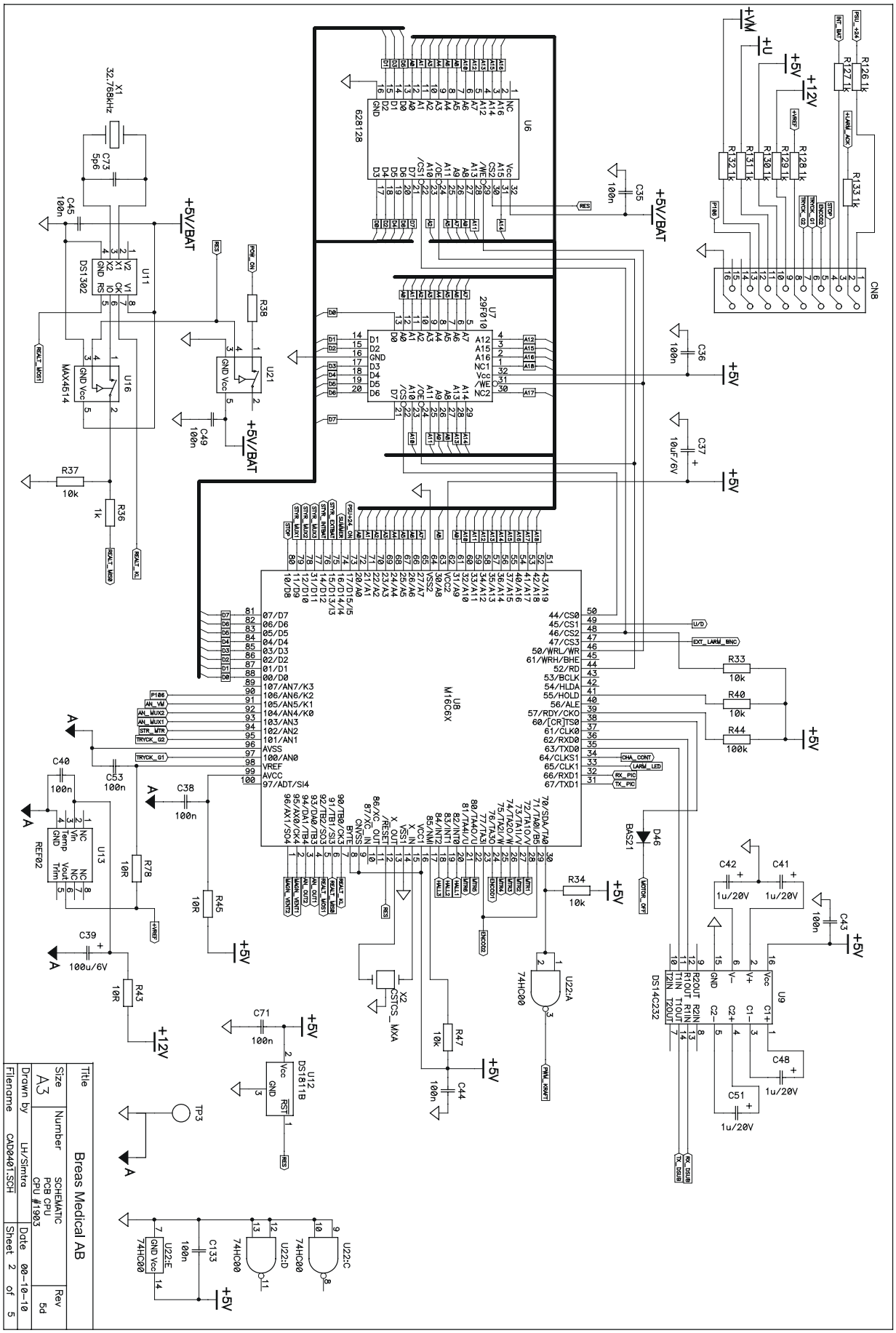
8.16.2 Circuit diagram – Alarm board, rev 5



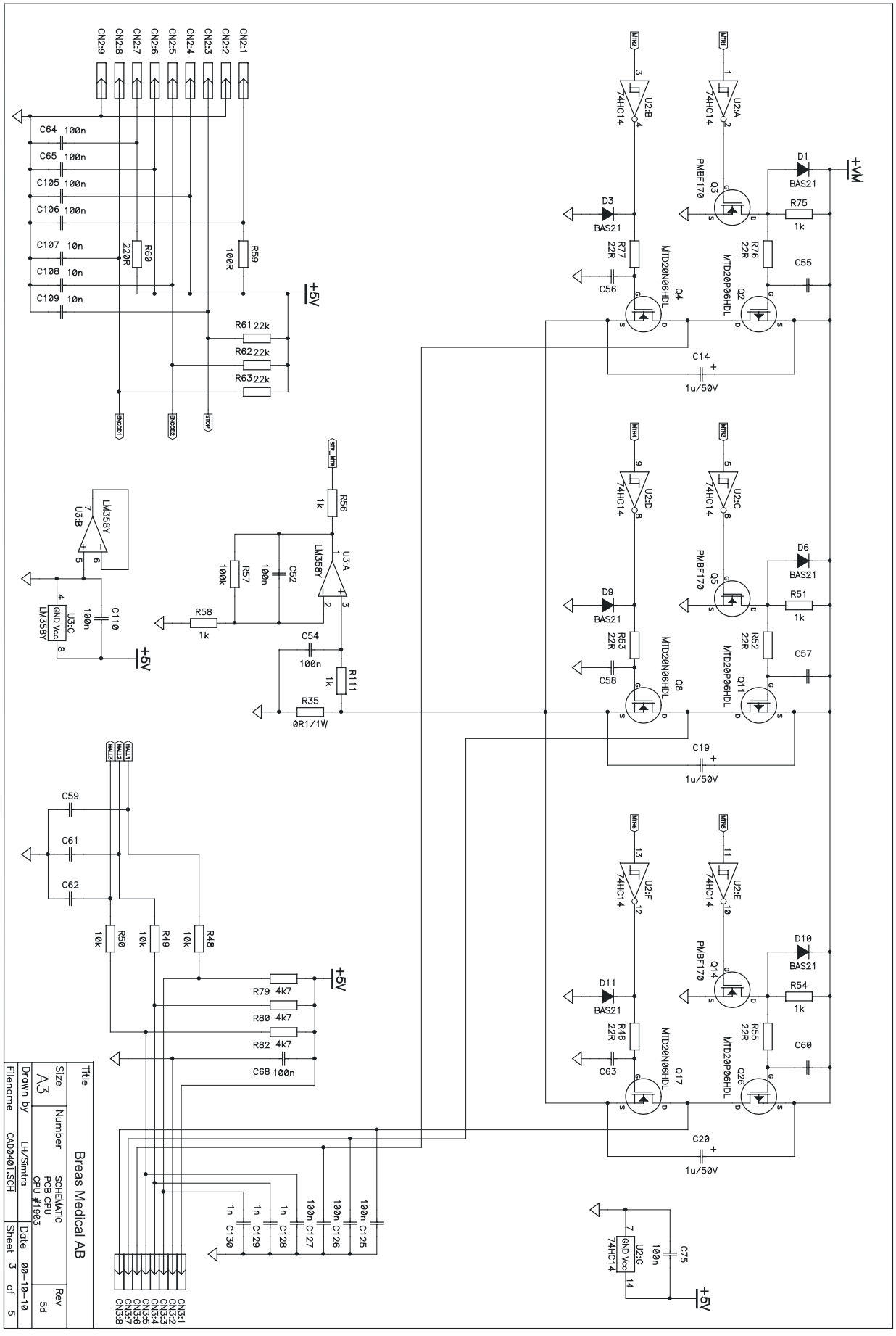
8.16.3 Circuit diagrams (5) – CPU board, rev 5D



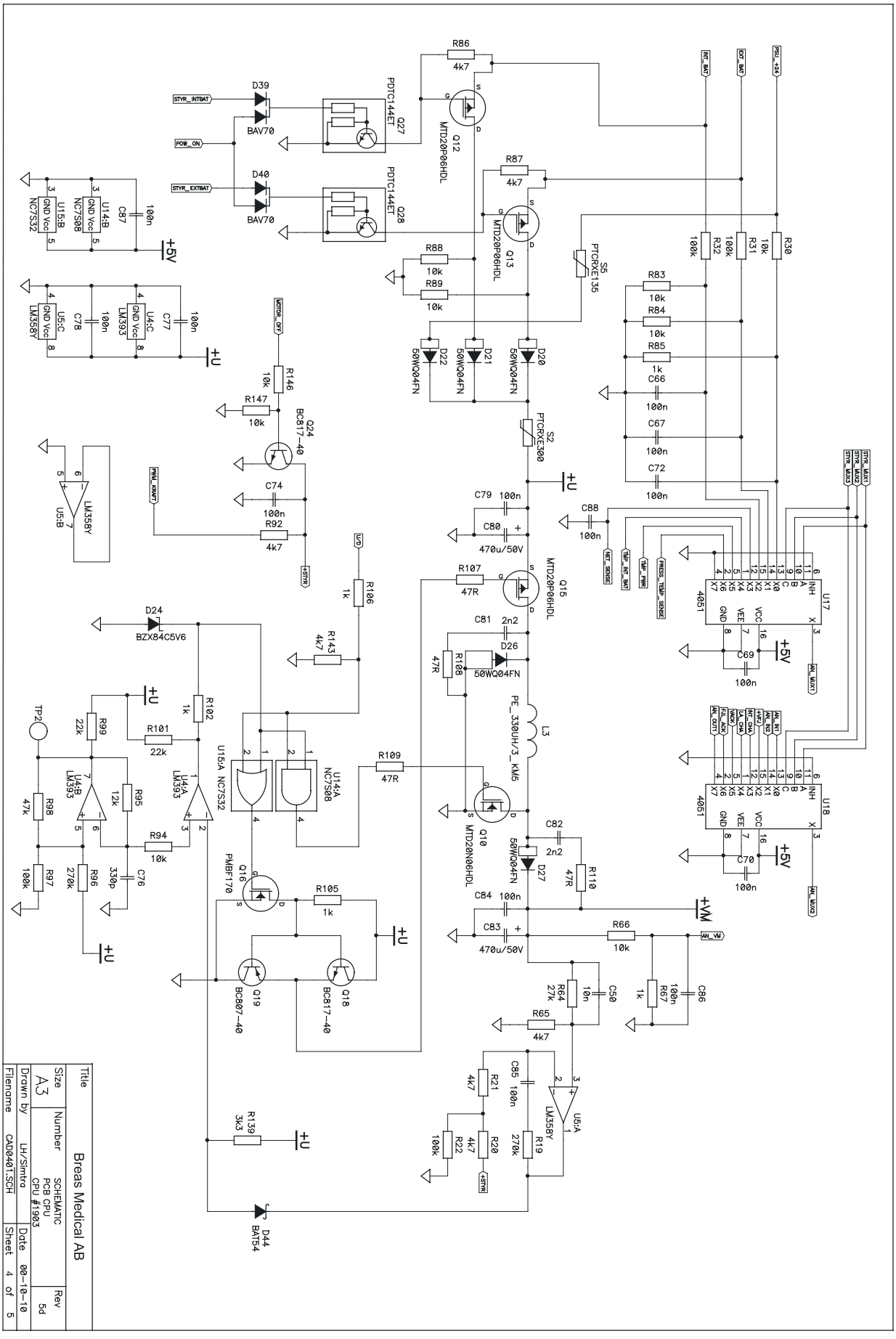
CPU board, rev 5D – circuit diagram no. 2



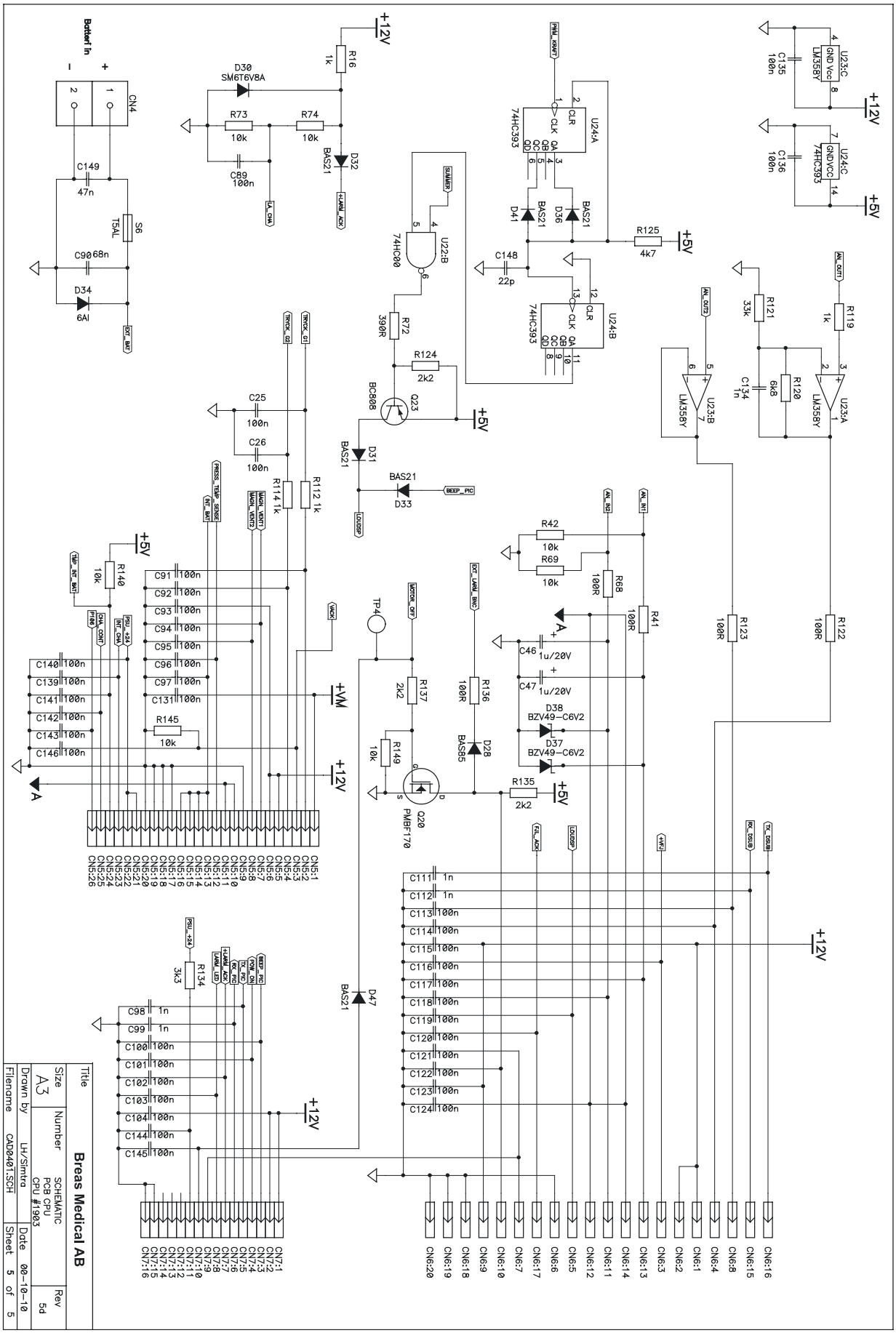
CPU board, rev 5D – circuit diagram no. 3



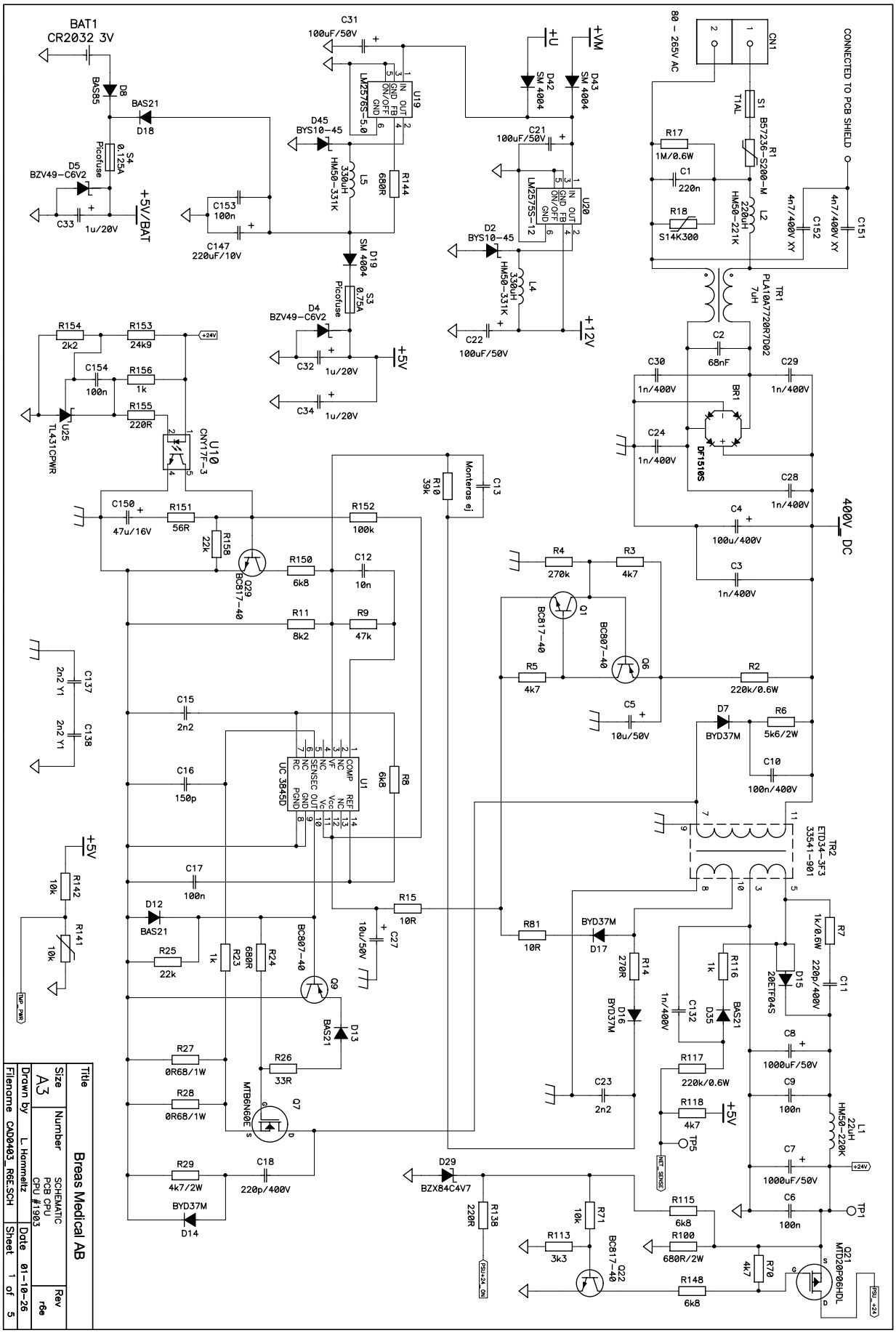
CPU board, rev 5D – circuit diagram no. 4



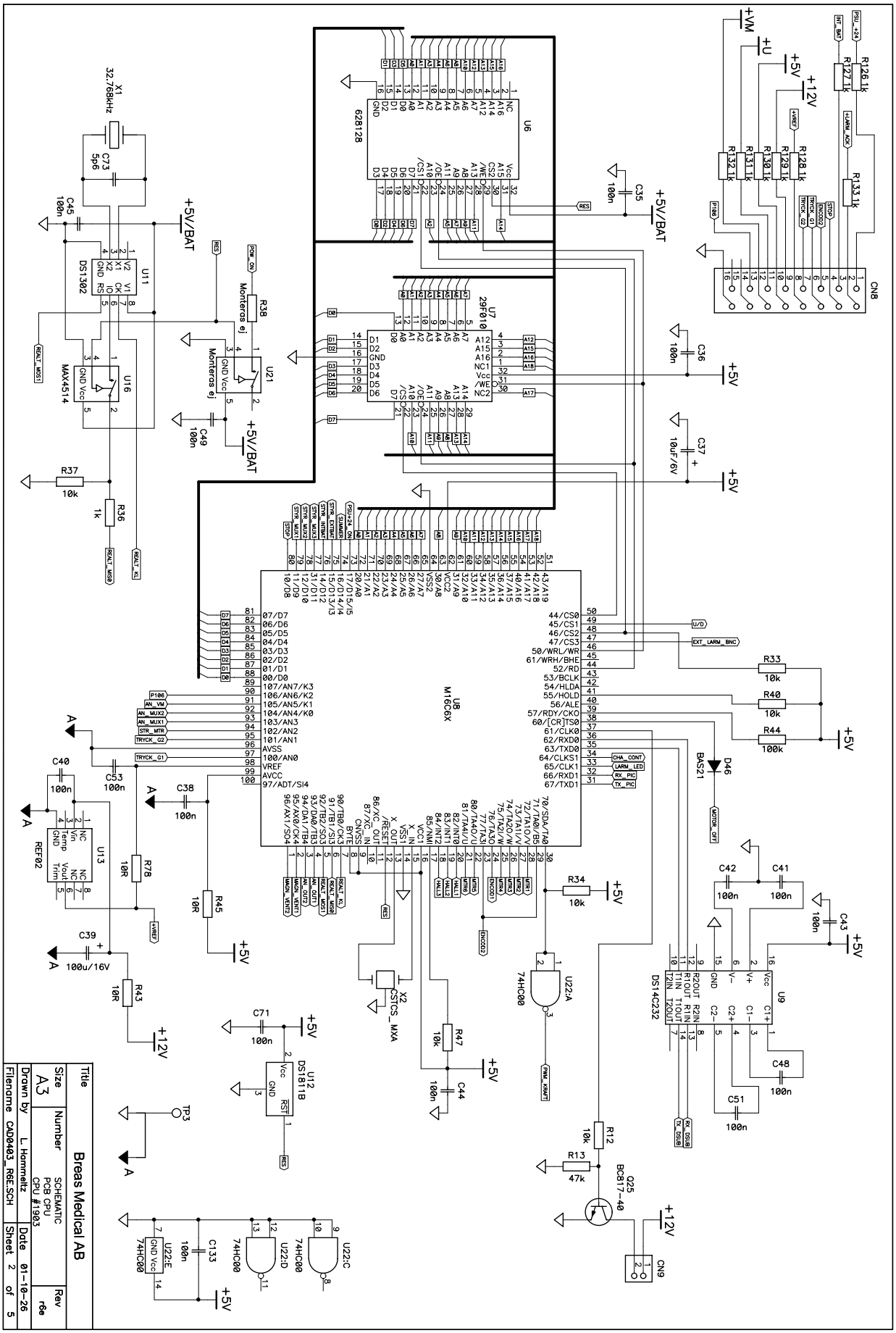
CPU board, rev 5D – circuit diagram no. 5



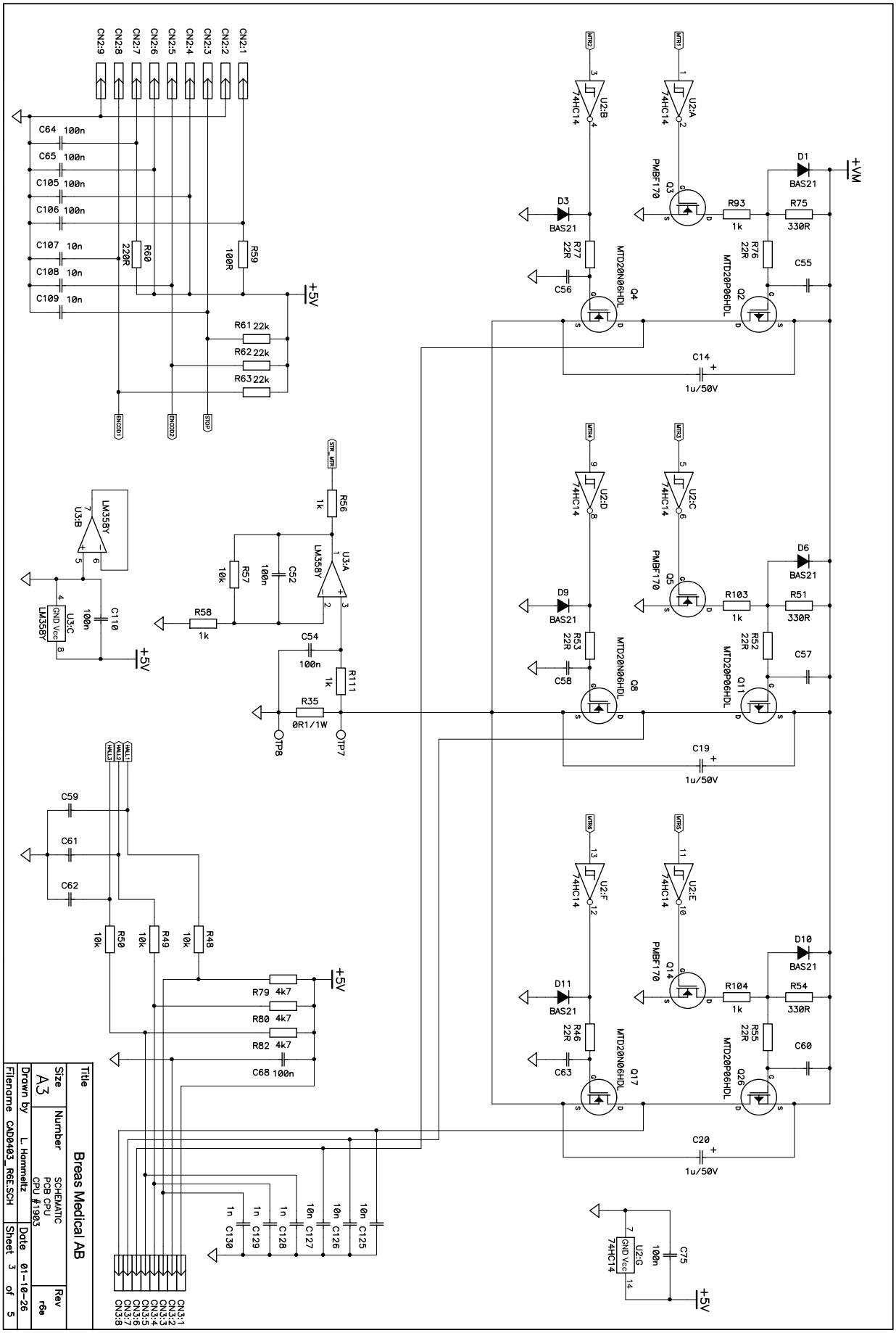
8.16.4 Circuit diagrams (5) – CPU board, rev 6E



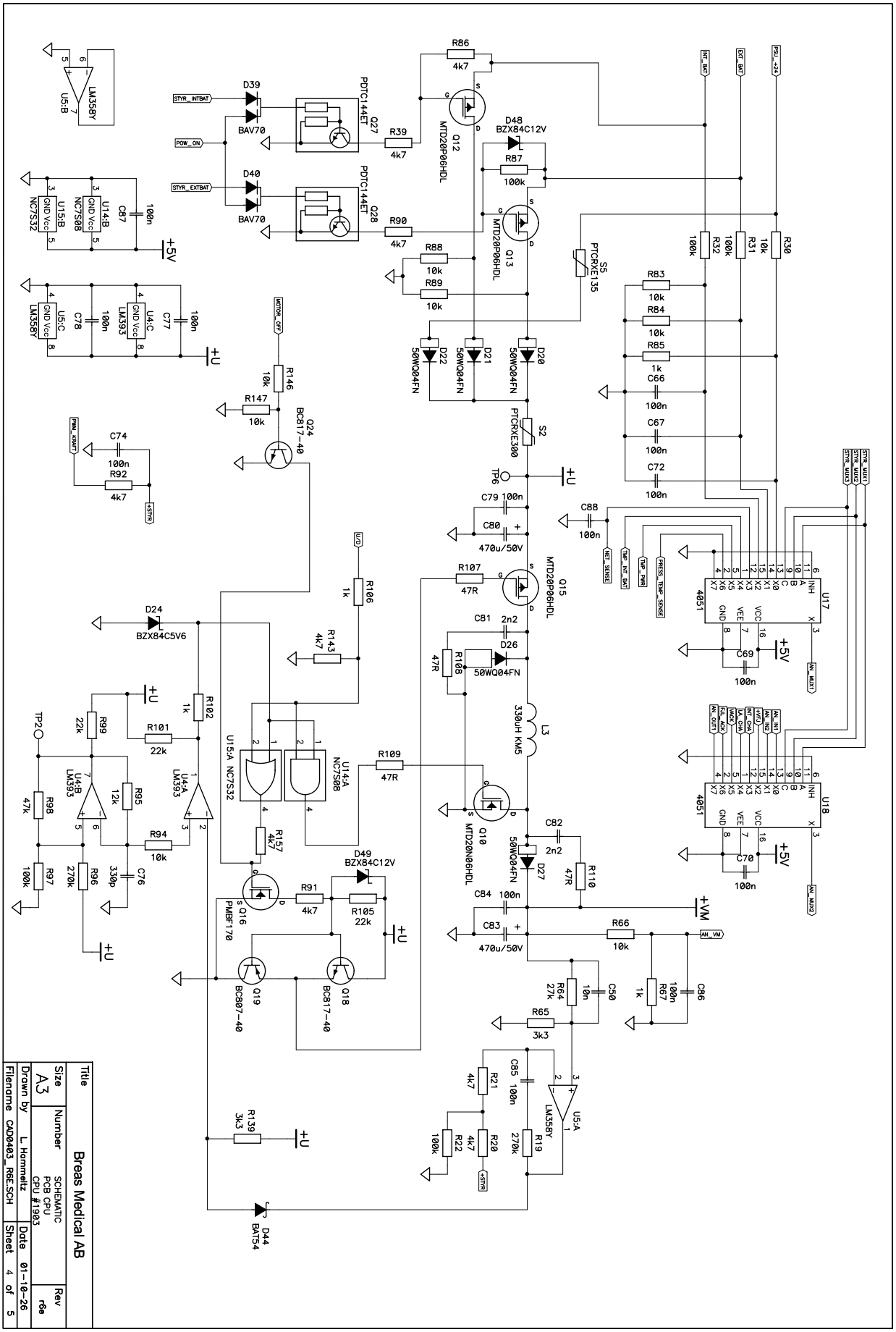
CPU board, rev 6E – circuit diagram no. 2



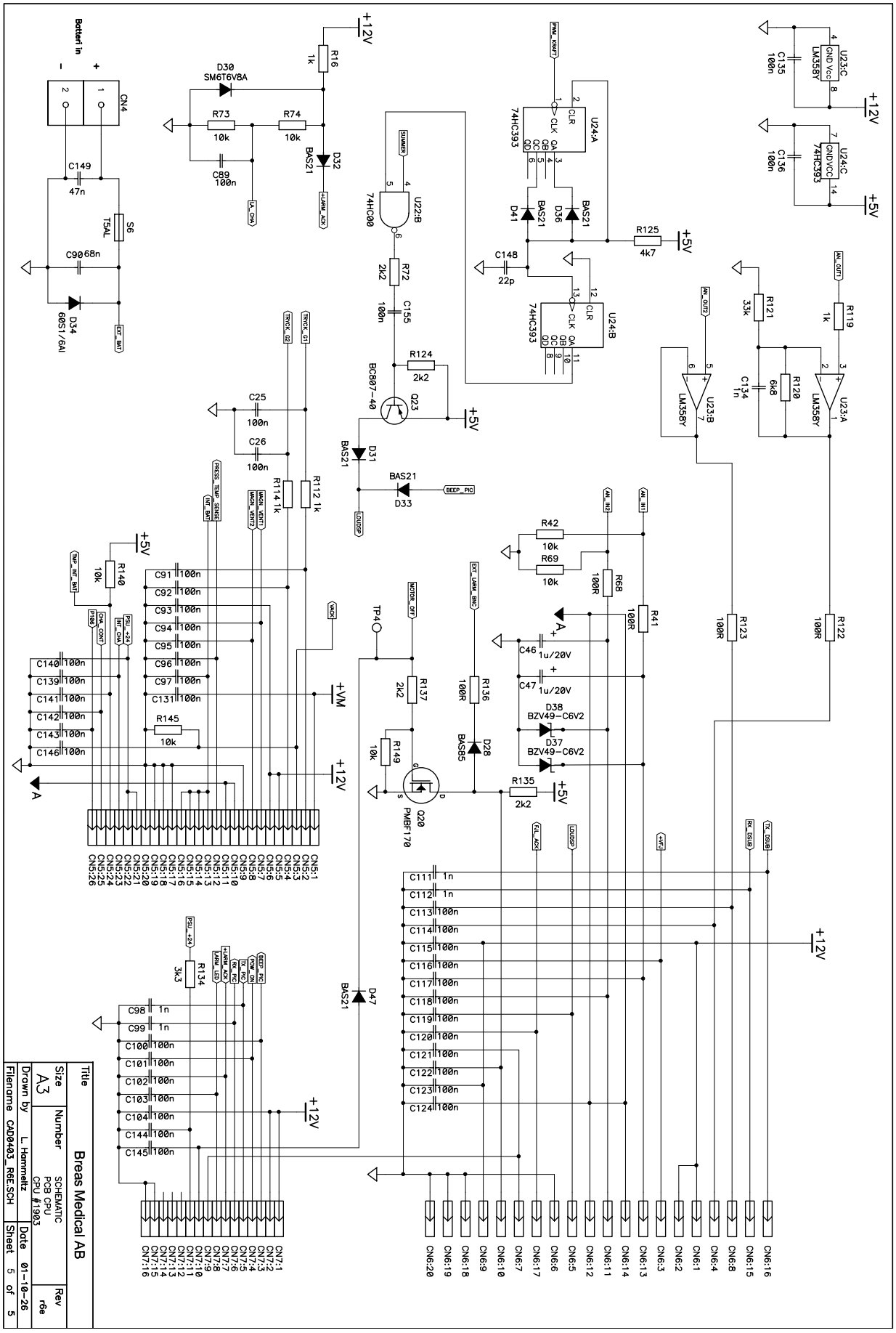
CPU board, rev 6E – circuit diagram no. 3



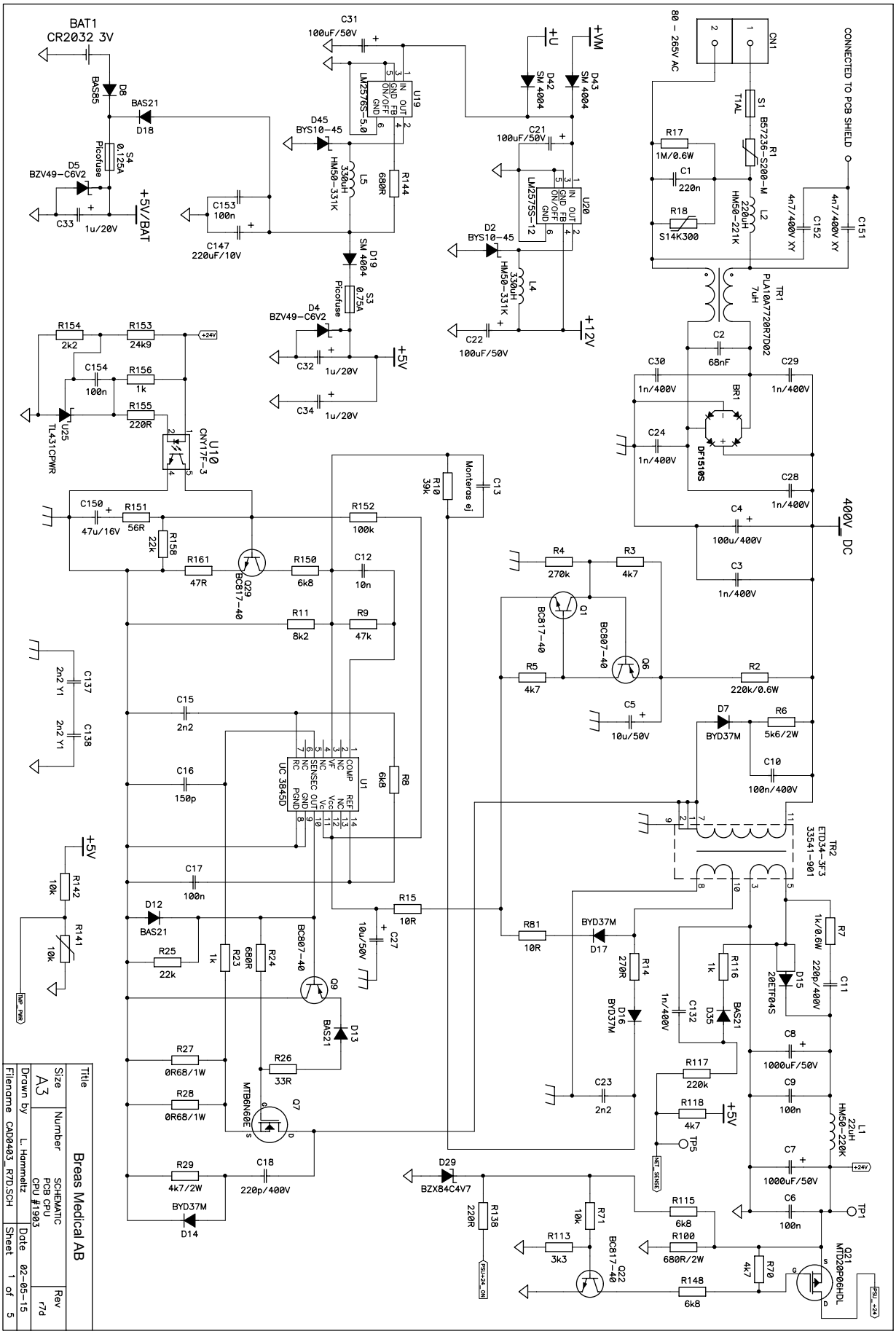
CPU board, rev 6E – circuit diagram no. 4



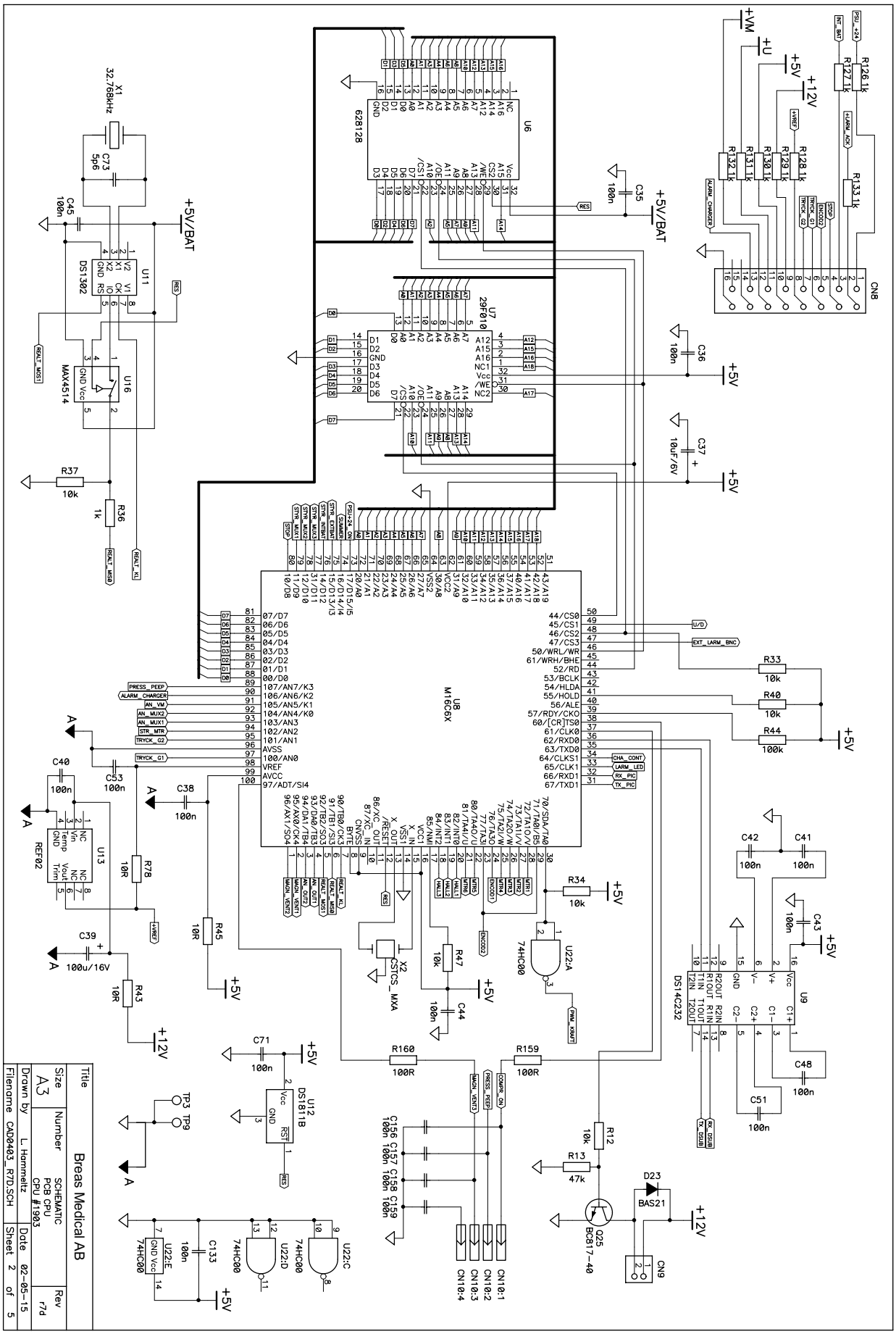
CPU board, rev 6E – circuit diagram no. 5



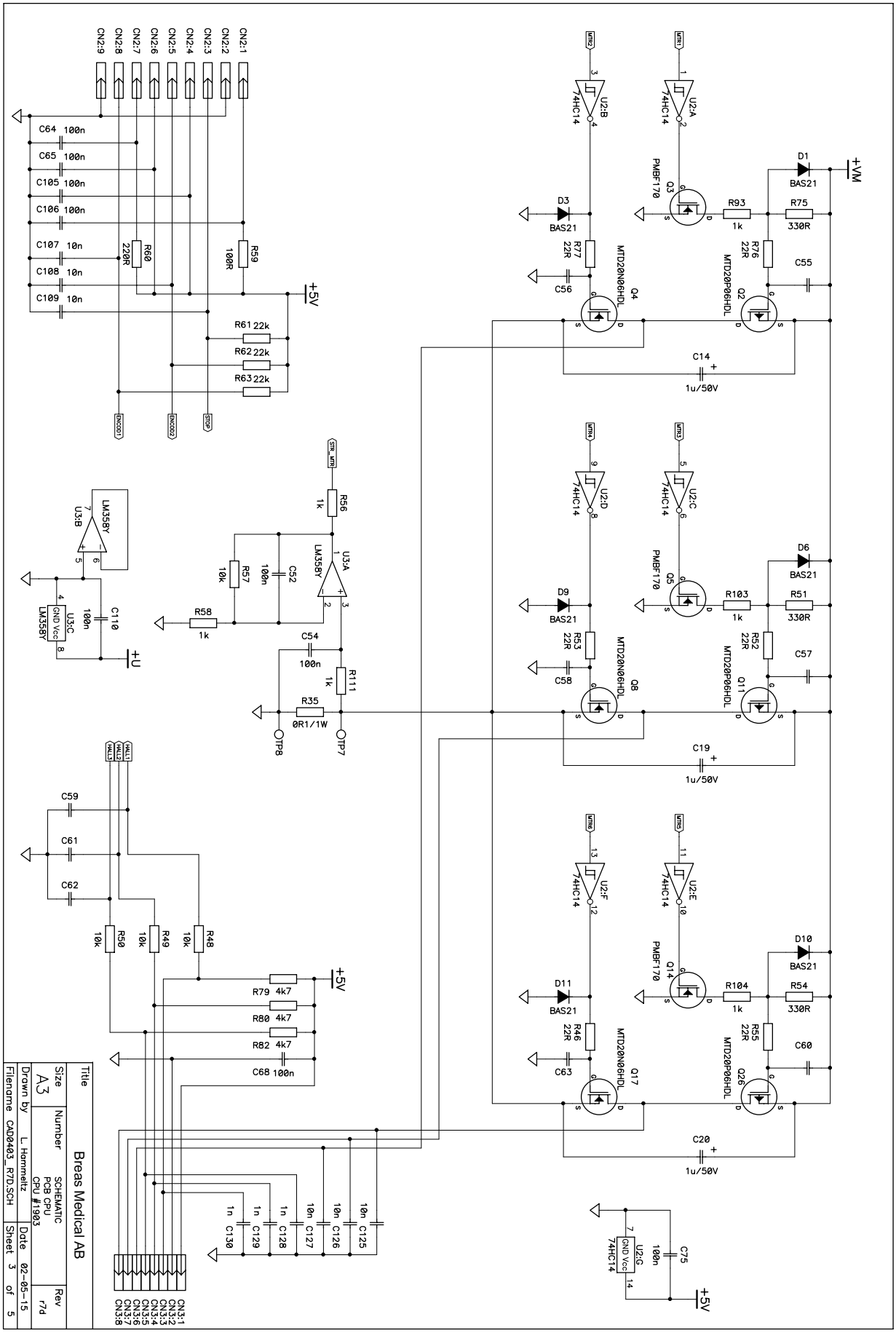
8.16.5 Circuit diagrams (5) – CPU board, rev 7D



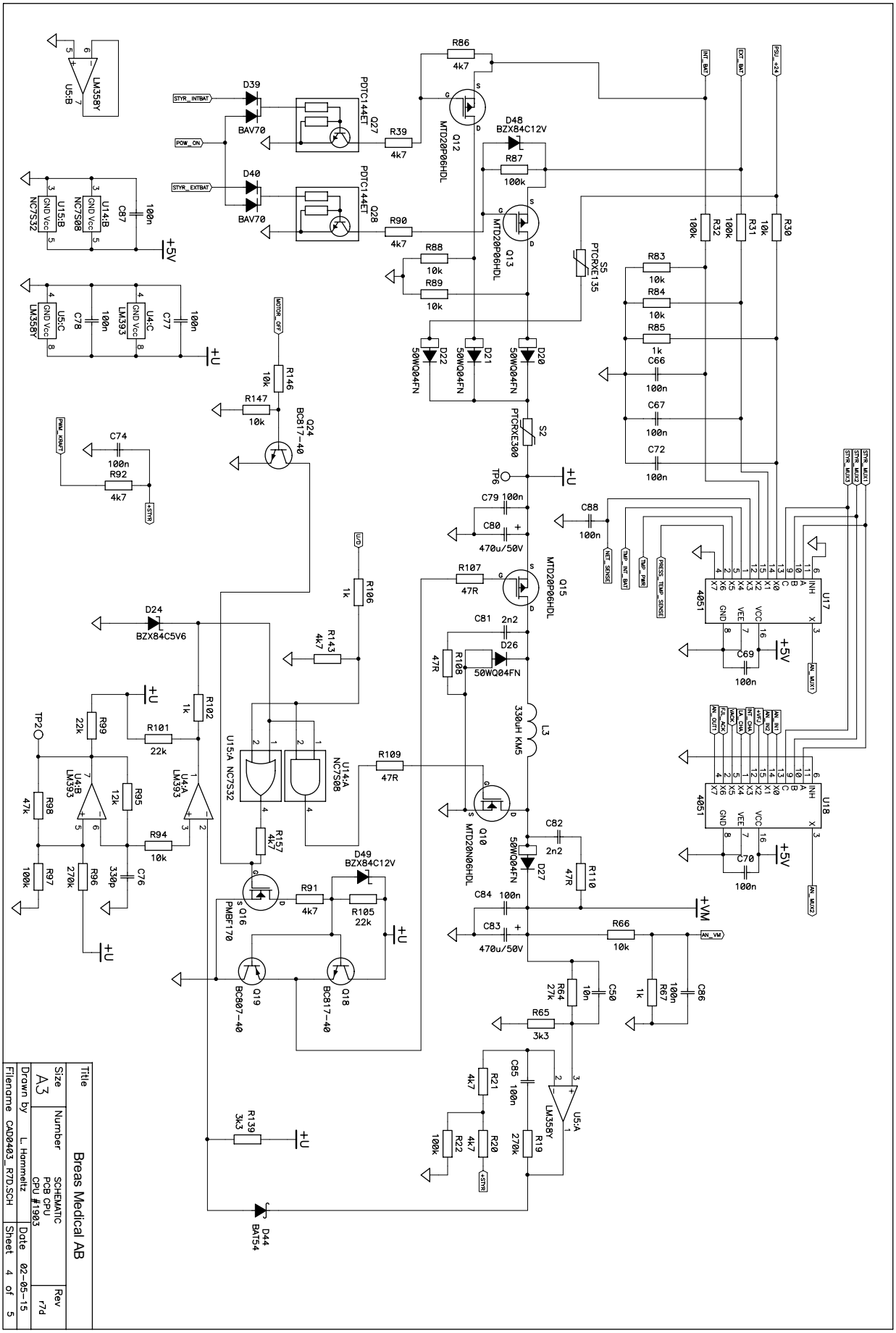
CPU board, rev 7D – circuit diagram no. 2



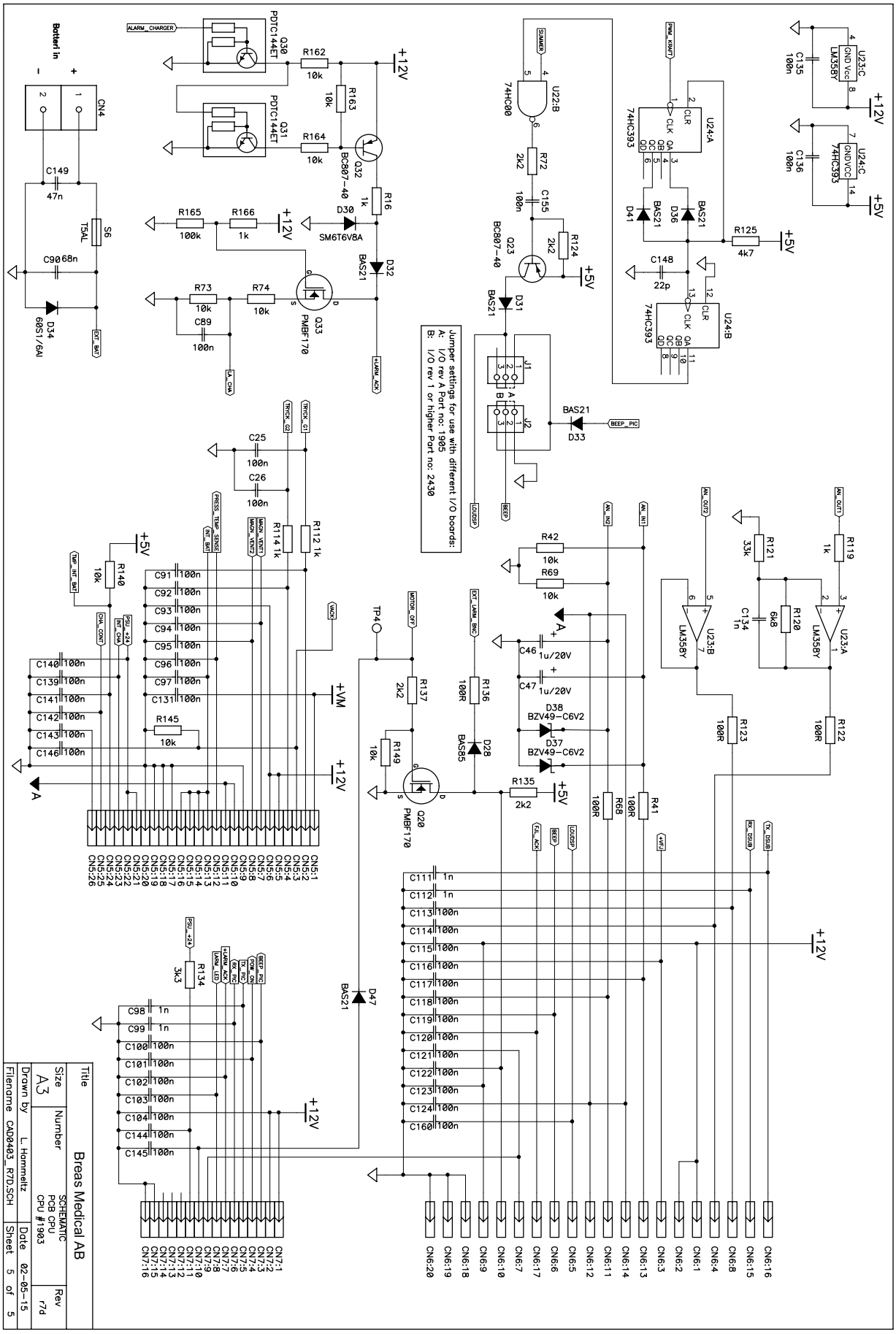
CPU board, rev 7D – circuit diagram no. 3



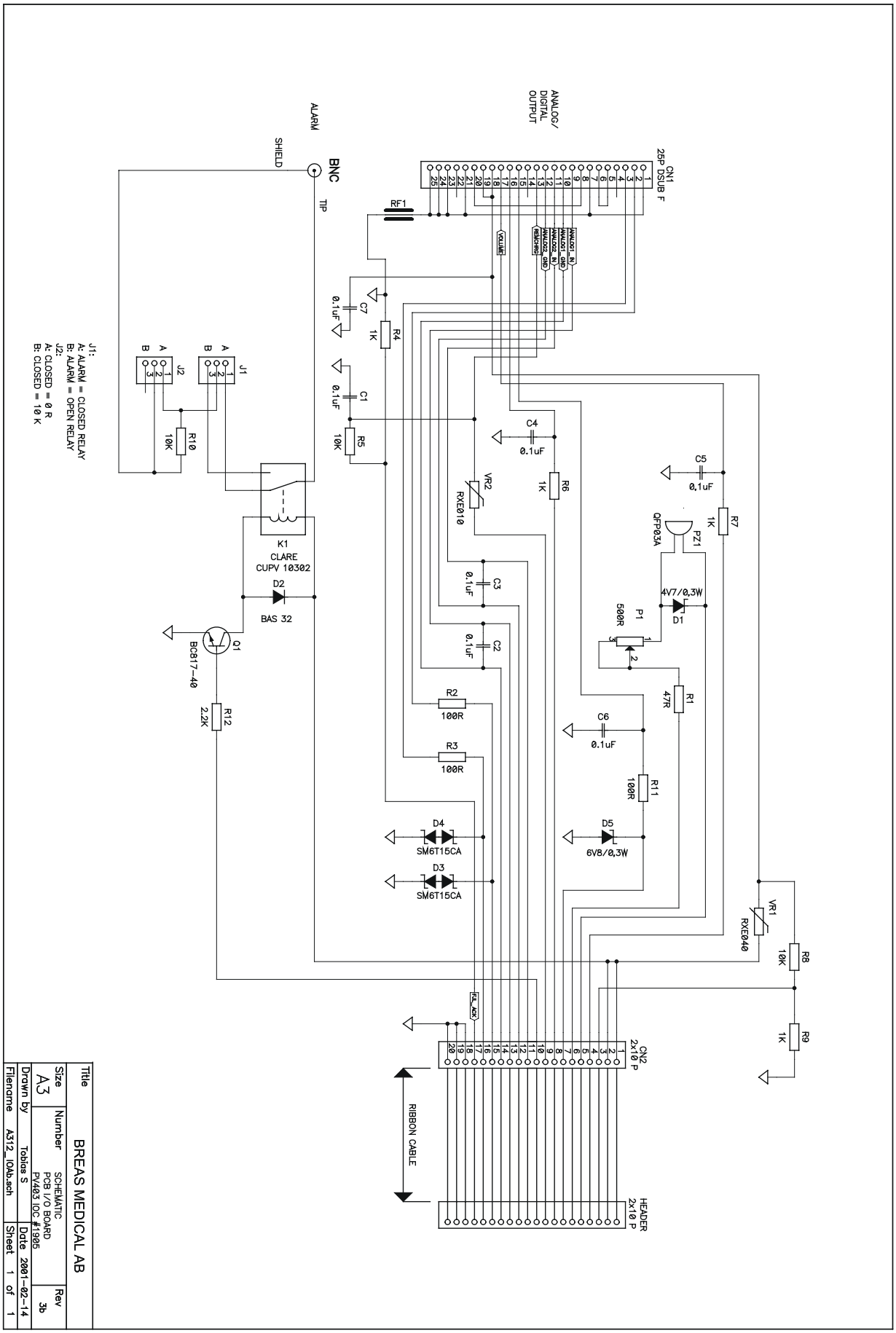
CPU board, rev 7D – circuit diagram no. 4



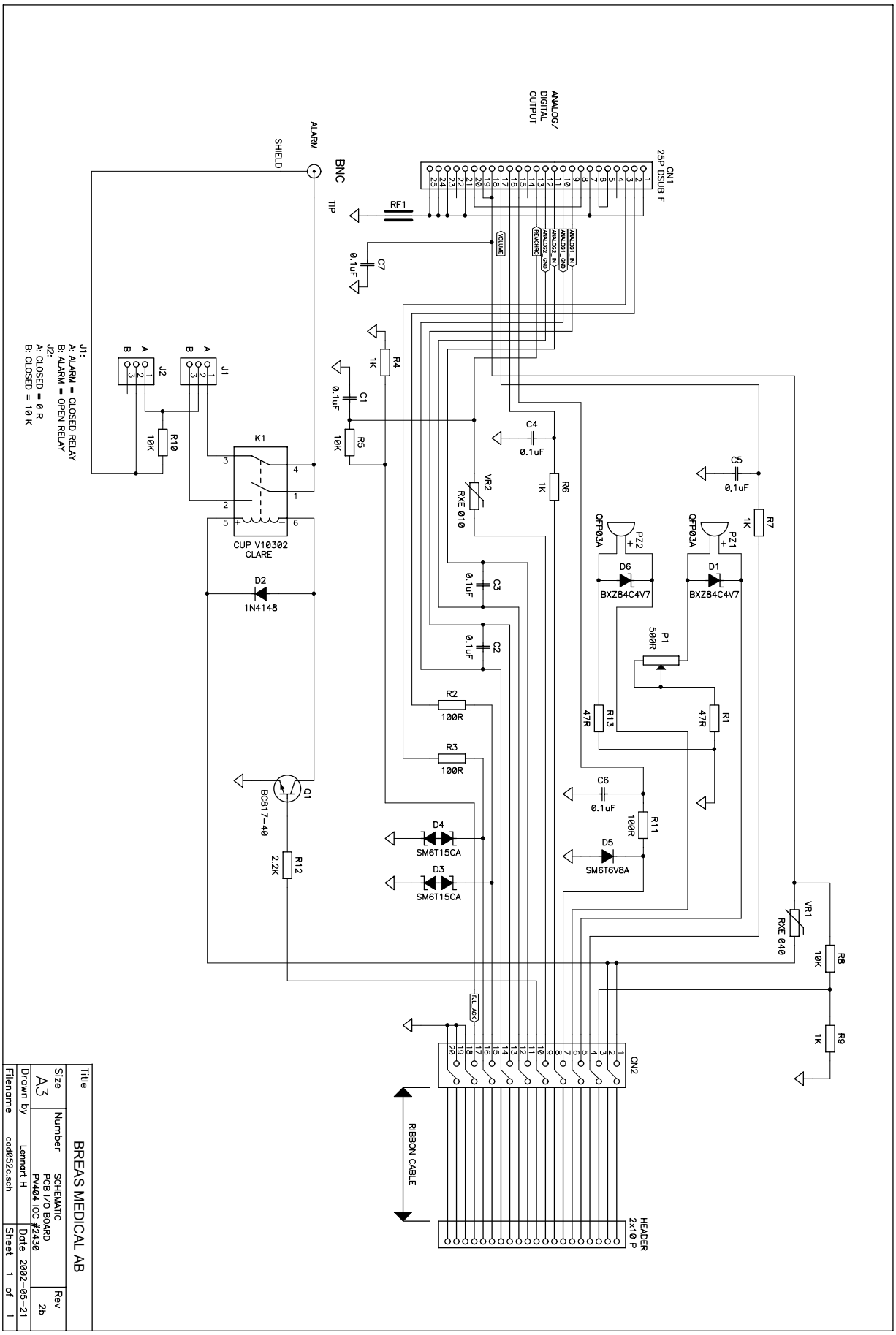
CPU board, rev 7D – circuit diagram no. 5



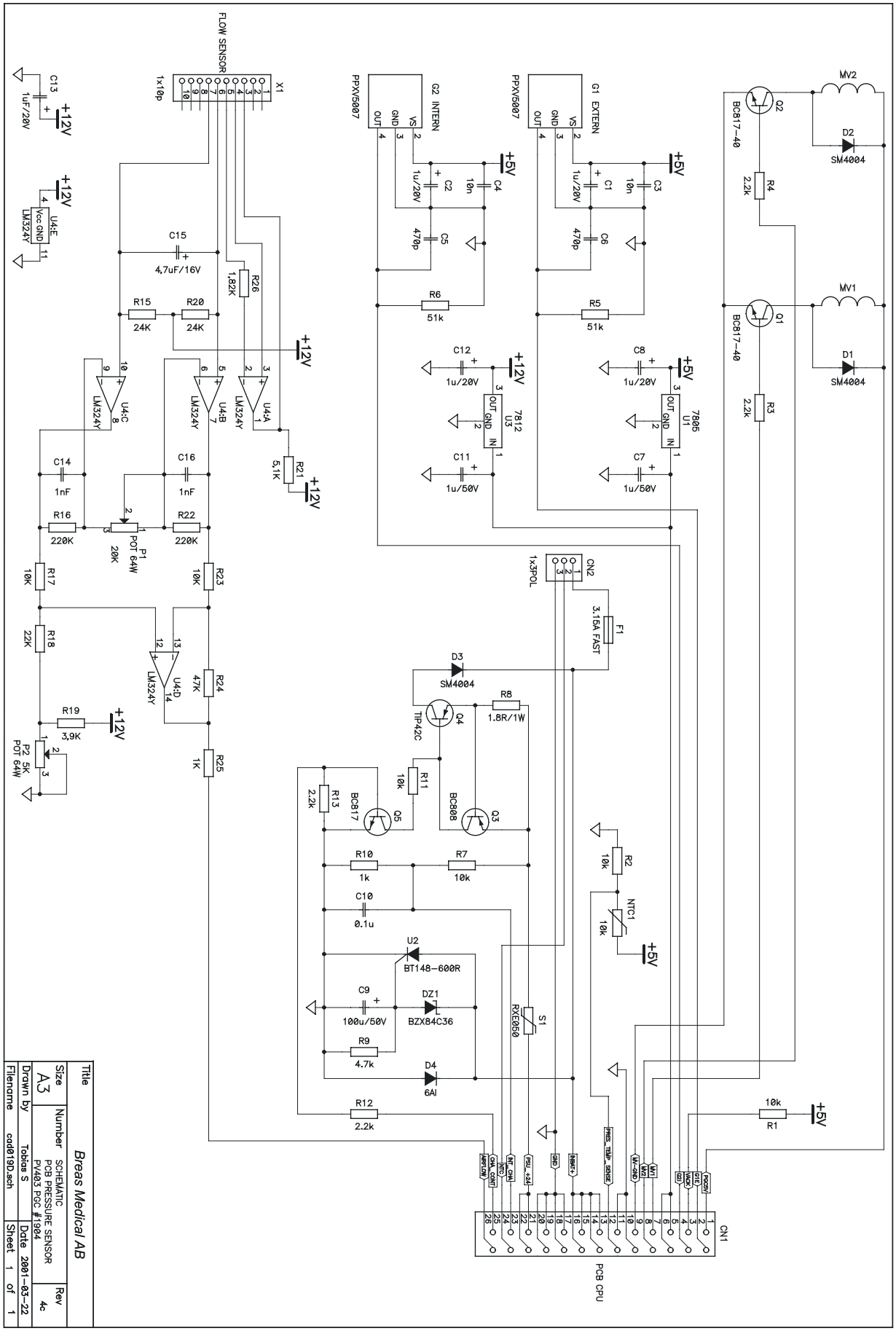
8.16.6 Circuit diagram – I/O board, rev A, art no 001905



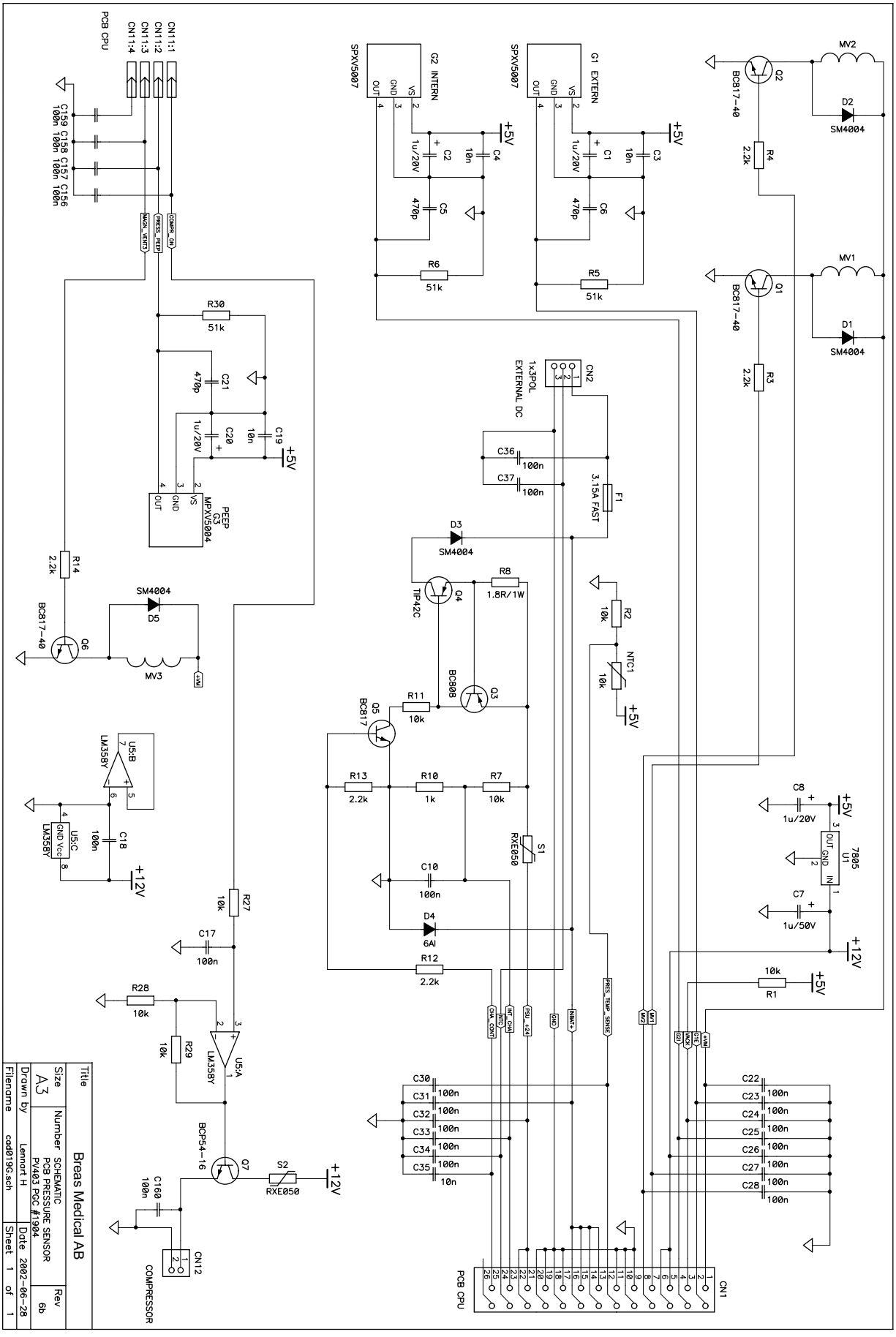
8.16.7 Circuit diagram – I/O board, rev 2, art no 002430



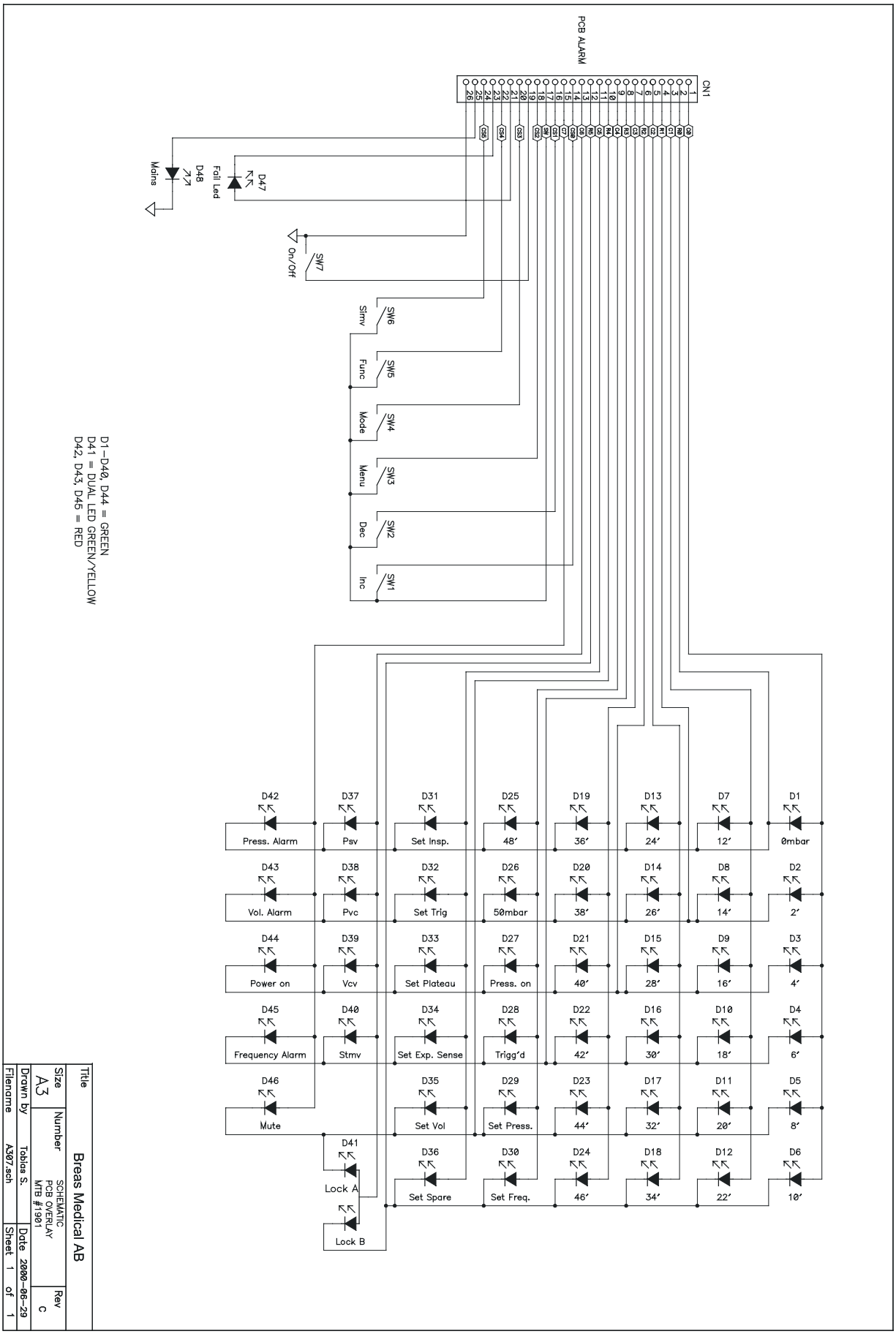
8.16.8 Circuit diagram – PGC board, rev 4C



8.16.9 Circuit diagram – PGC board, rev 6B



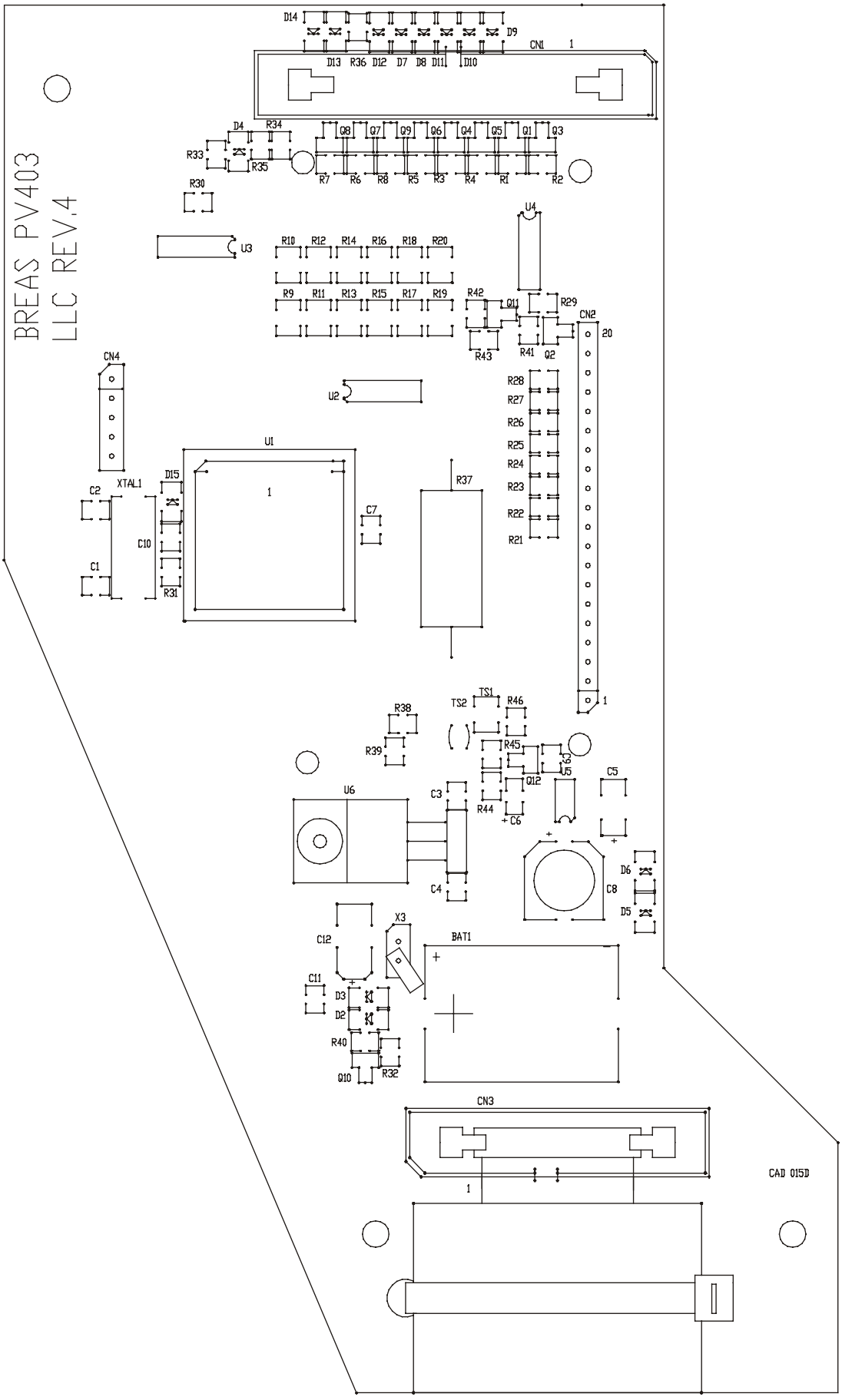
8.16.10Circuit diagram – Push-button membrane panel



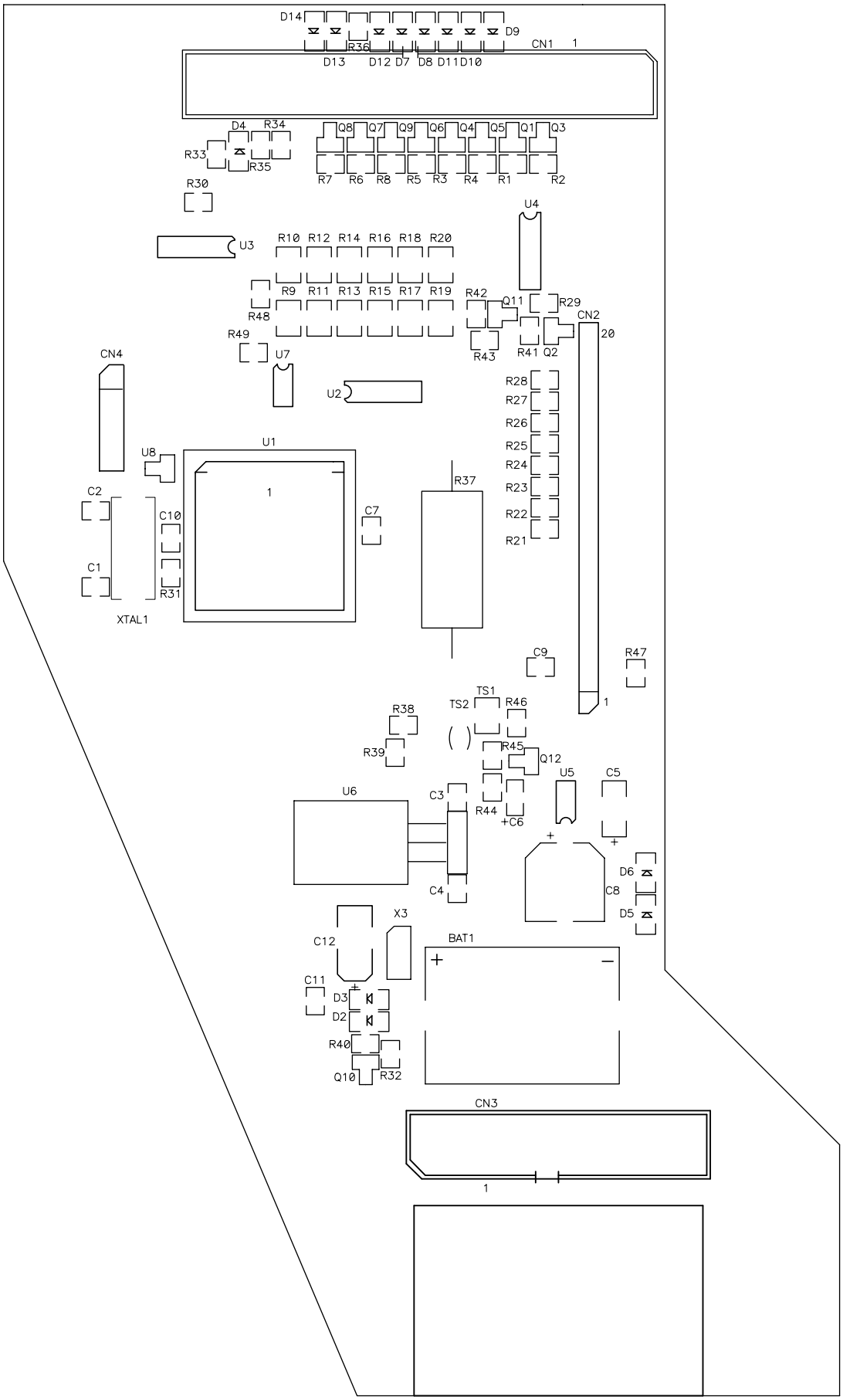
8.17 Component location drawings

This section contains the component location drawings for the alarm board, the CPU board, the I/O board, the PGC board, the push-button membrane panel, the rear panel, and the cables.

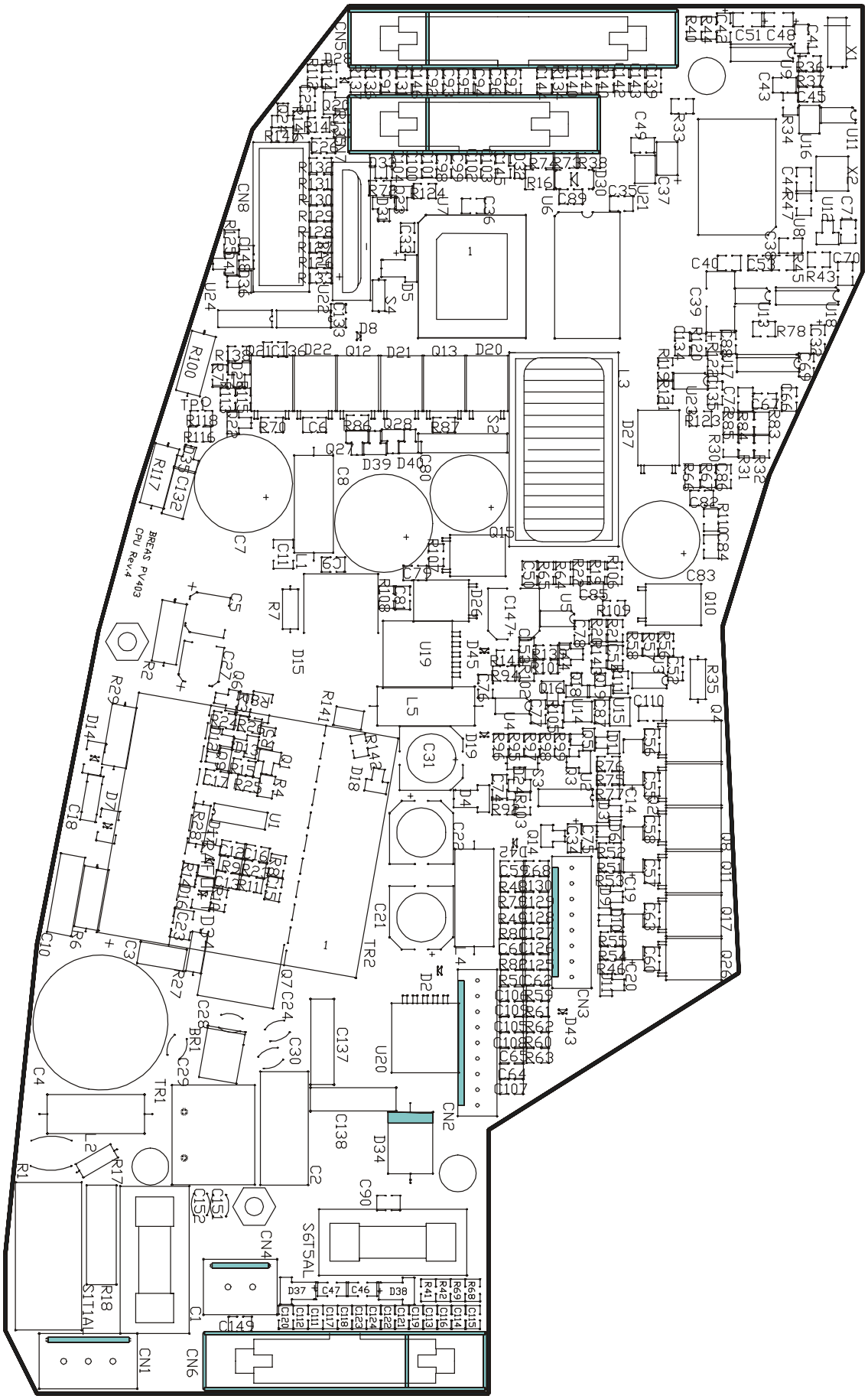
8.17.1 Component location drawing – Alarm board, rev 4



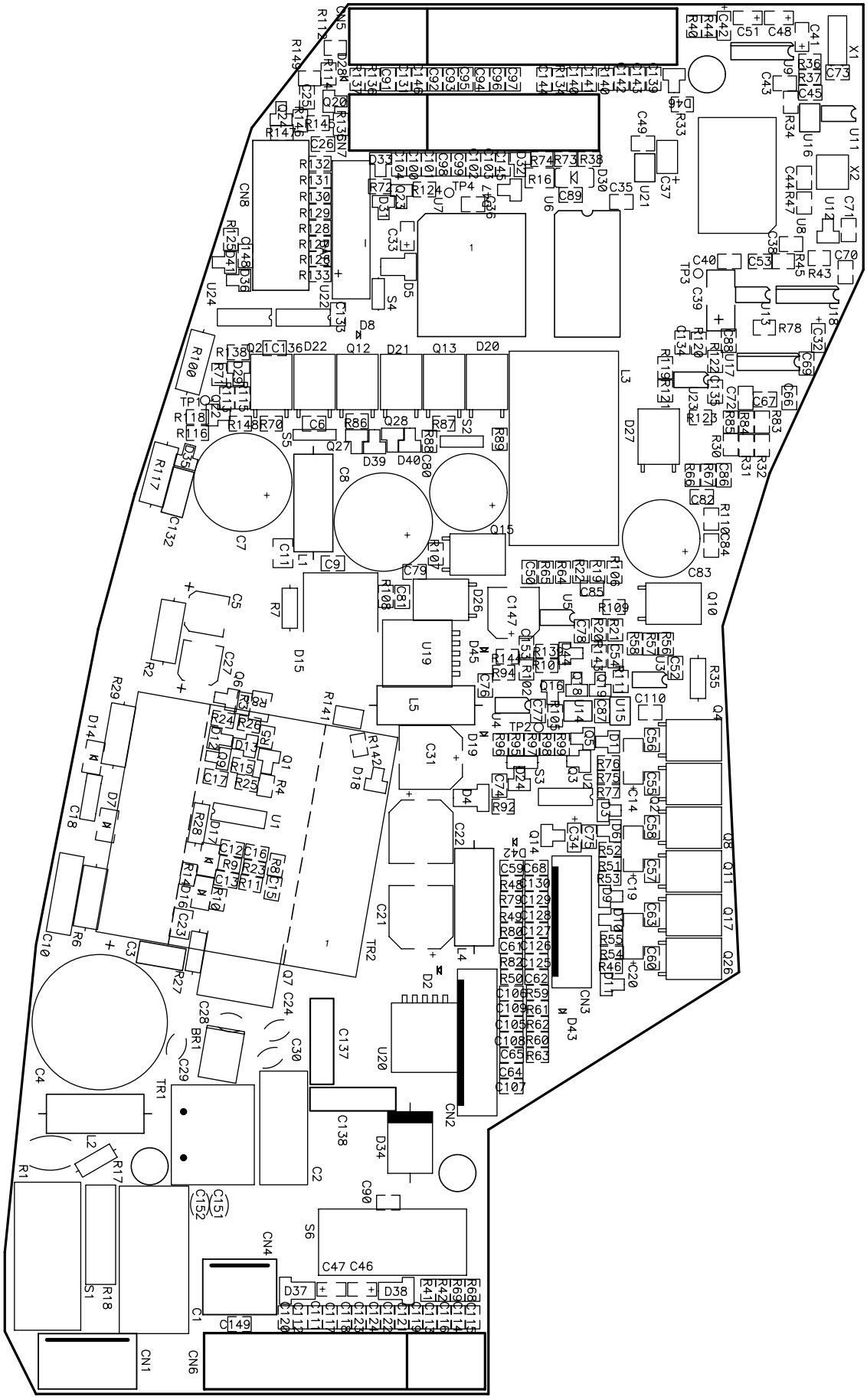
8.17.2 Component location drawing – Alarm board, rev 5



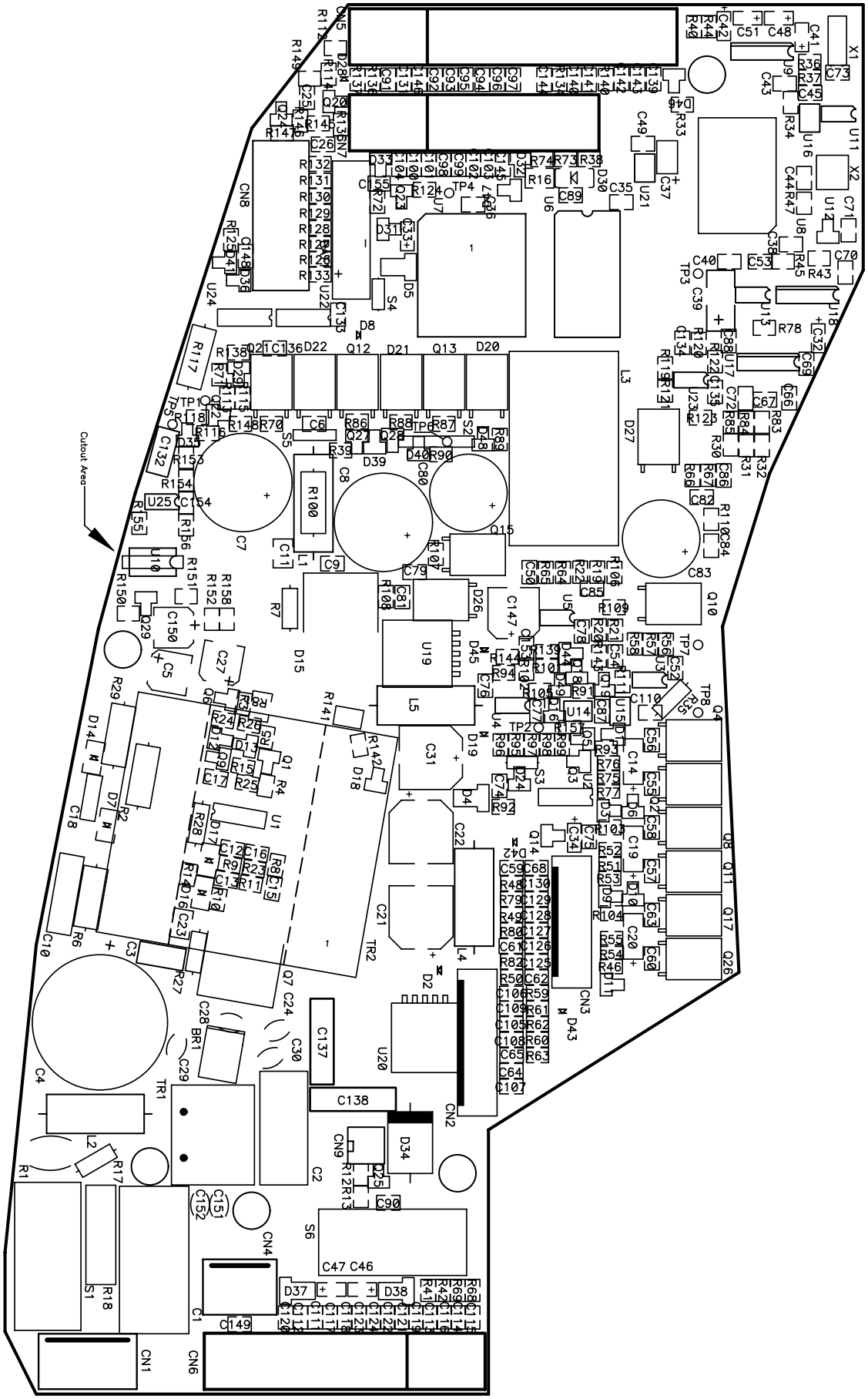
8.17.3 Component location drawing – CPU board, rev 4



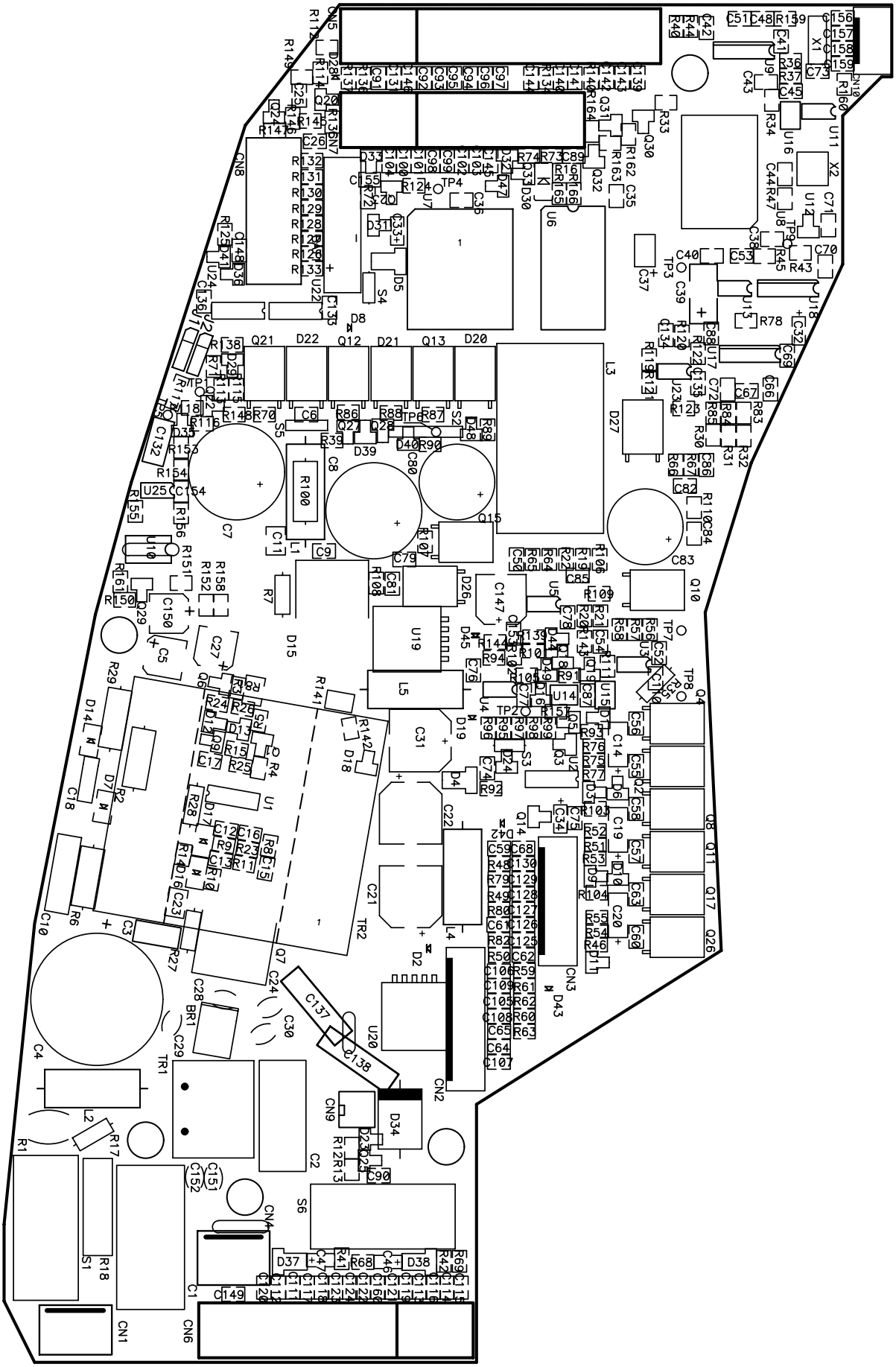
8.17.4 Component location drawing – CPU board, rev 5C



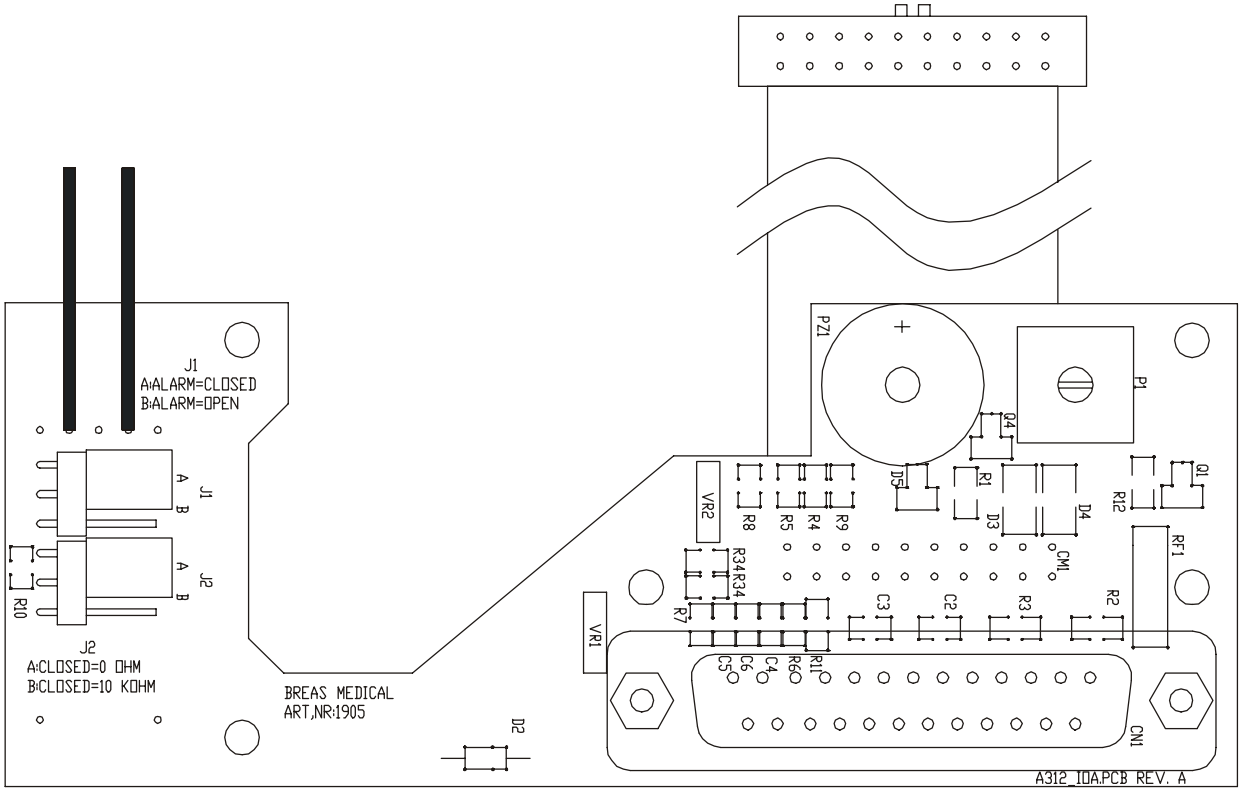
8.17.5 Component location drawing – CPU board, rev 6B and C



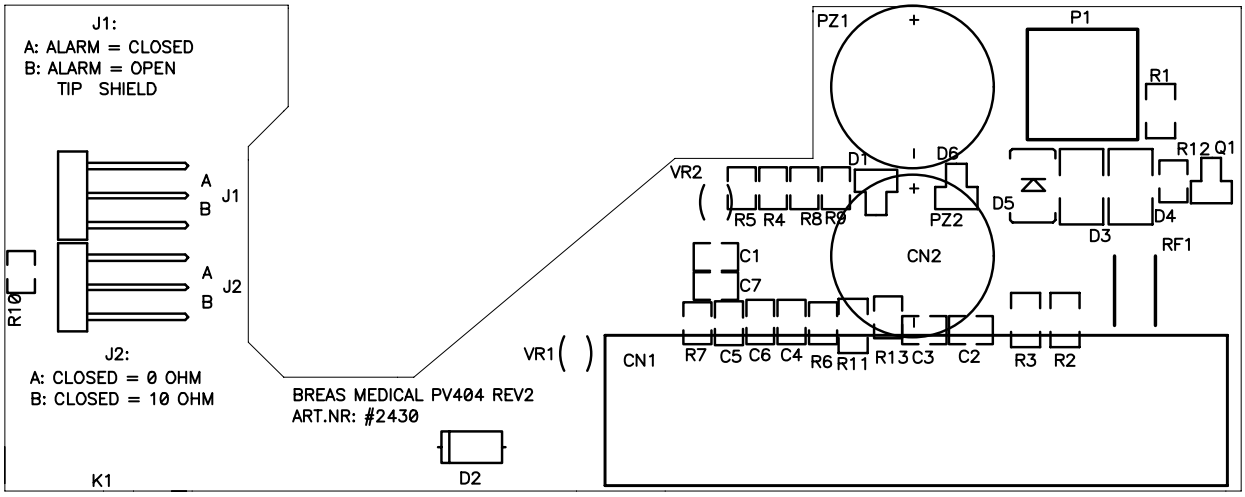
8.17.6 Component location drawing – CPU board, rev 7B



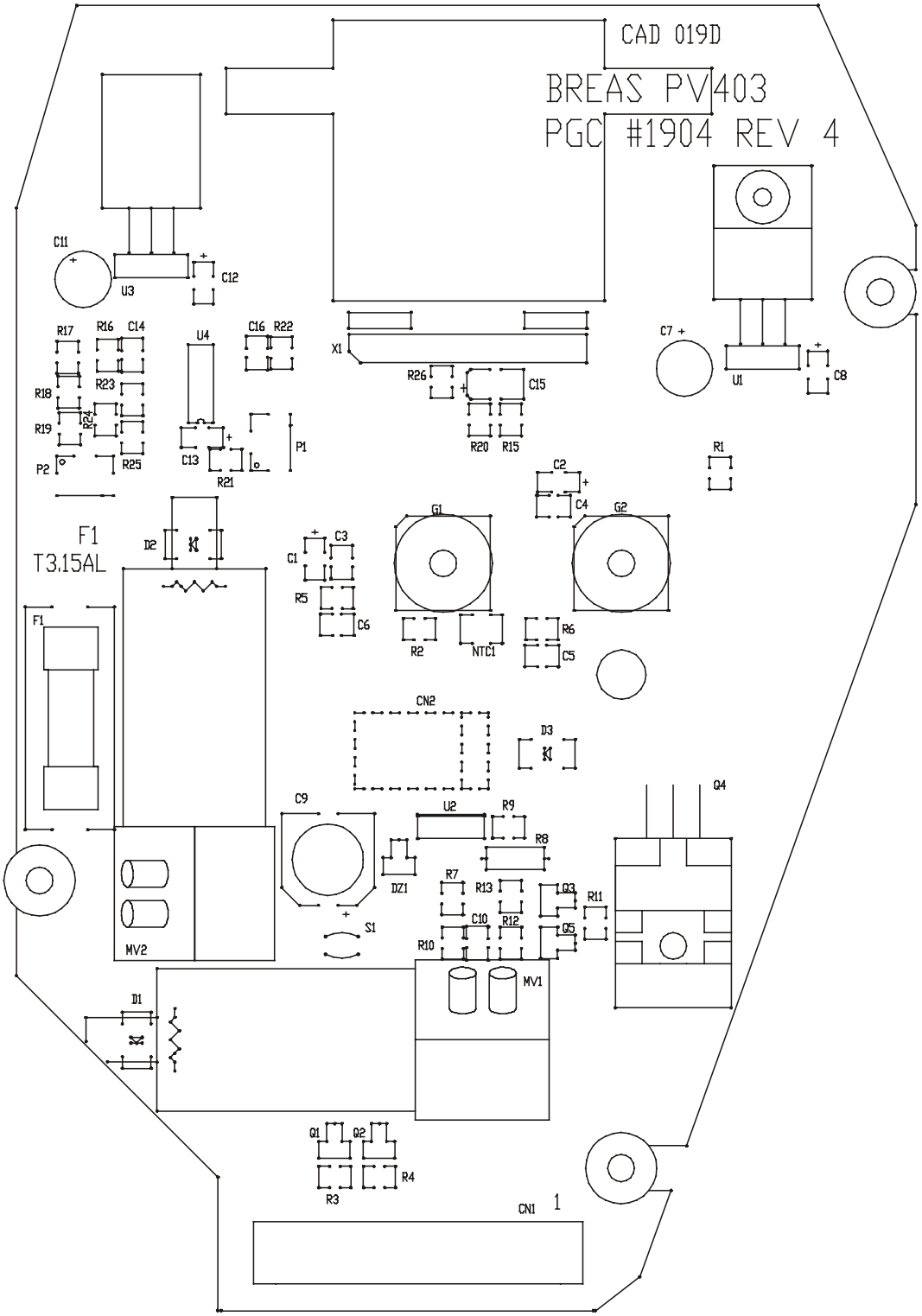
8.17.7 Component location drawing – I/O board, rev A, art no 001905



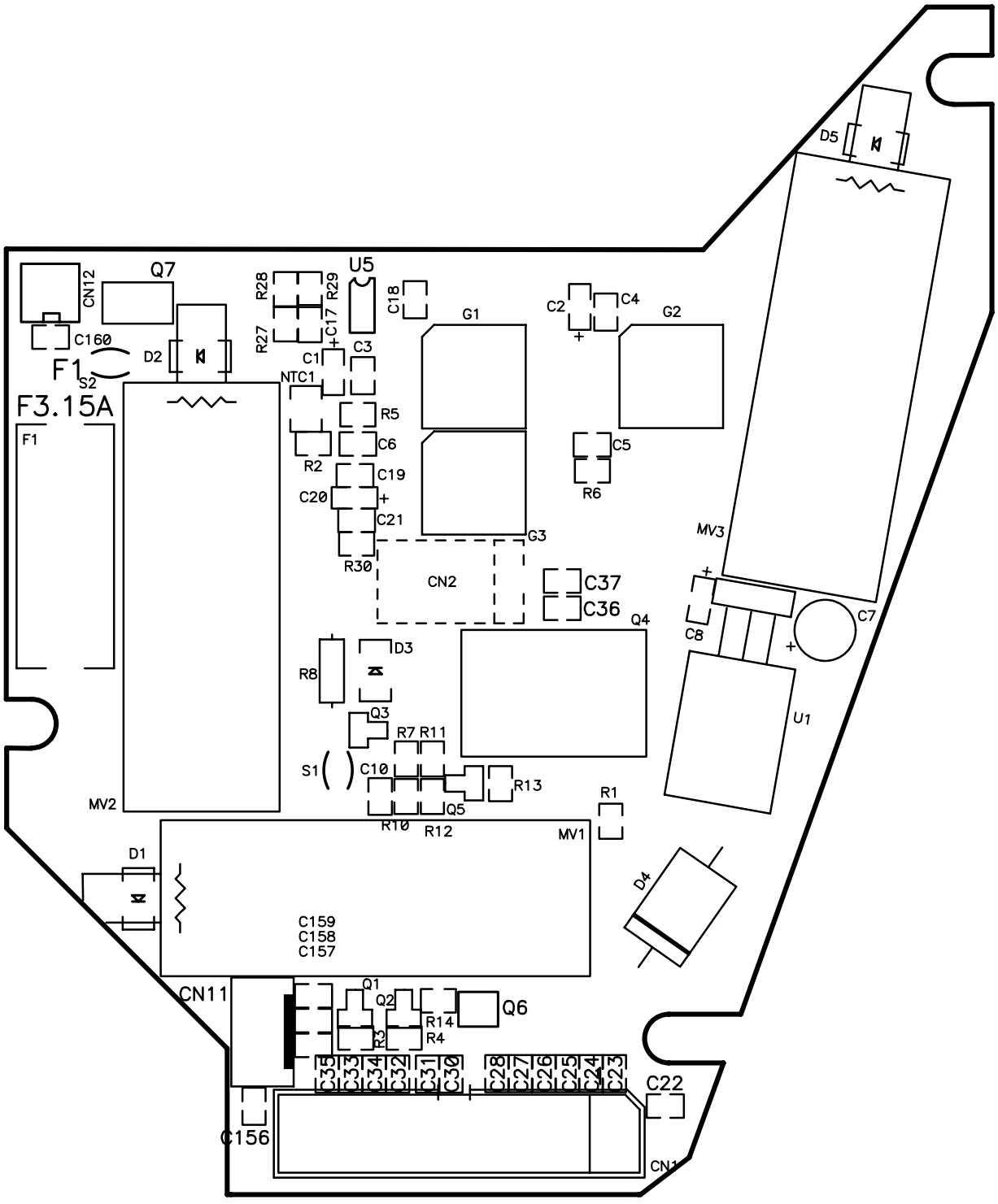
8.17.8 Component location drawing – I/O board, rev 2, art no 002430



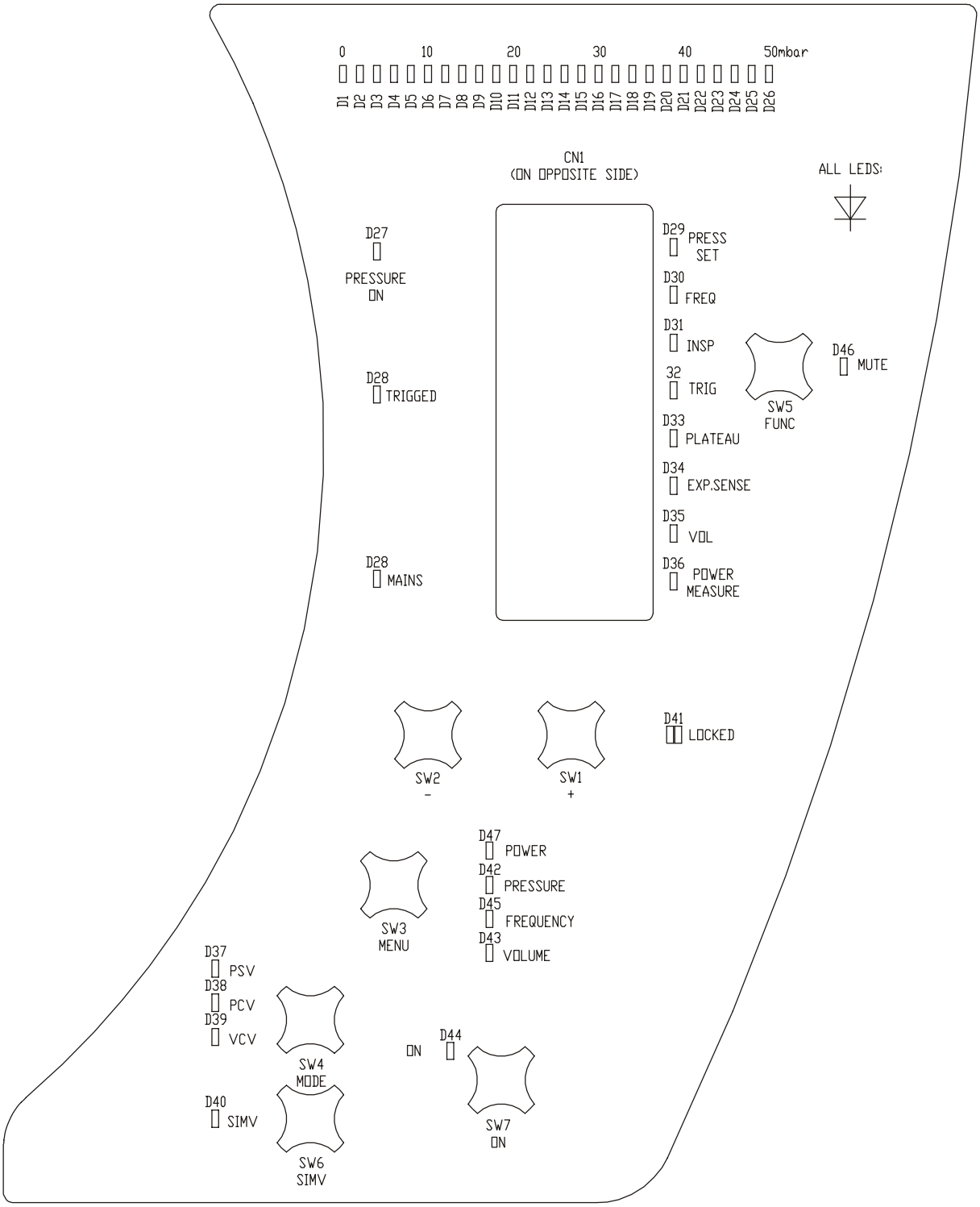
8.17.9 Component location drawing – PGC board, rev 4



8.17.10Component location drawing – PGC board, rev 6B



8.17.11Component location drawing – Push-button membrane panel



8.18 Lists of components

This section contains the lists of components for the alarm board, the CPU board, the I/O board, the PGC board, the push-button membrane panel, the rear panel, and the push-button membrane panel.

8.18.1 List of components – Alarm board, rev 4

Reference	Description	Quantity
	CABLE TIE 150 mm	1
	DISTANCE DLCBSTE-7-01	4
	JUMPER SWITCH	1
	LCD DISPLAY PG12232-LRS-ANN-B	1
(CN2)	MALE POST HEADER 1 × 20-POLE STRAIGHT	1
(U1)	IC-SOCKET	1
BAT1	BATTERY 4.8 V, 70 mAh	1
C1, 2	CAPACITOR 15 pF NP0	2
C12	Not to be mounted	1
C3, 4, 7, 9, 10, 11	CAPACITOR 0.1 µF X7R	6
C5	CAPACITOR 10 µF, 16 V	1
C6	CAPACITOR, TANTALUM 1 µF, 20 V	1
C8	CAPACITOR 100 µF, 50 V CV-AX	1
CN1	HEADER CONNECTOR 2 × 13-POLE EJECTOR	1
CN2	FEMALE RECEPTABLE 1 × 20-POLE STRAIGHT	1
CN3	HEADER CONNECTOR 2 × 8-POLE EJECTOR	1
CN4	MALE POST HEADER 1 × 5-POLE STRAIGHT	1
D2–4, 15	DIODE BAS85	4
D5–14	DIODE BAS32	10
Q1, 3–12	TRANSISTOR BC808-25	11
Q2	TRANSISTOR BC817-40	1
R1–8, 38, 41–43	RESISTOR 10K 1%	12
R21–28, 35, 47	RESISTOR 100R 1%	10
R29, 30, 32, 40	RESISTOR 2K2 1%	4
R31	RESISTOR 10R 1%	1
R33	RESISTOR 1K 1%	1
R34	RESISTOR 470R 1%	1
R36	RESISTOR 220R 1%	1

Reference	Description	Quantity
R37	RESISTOR 47R 4W 5%	1
R39	RESISTOR 3K9 1%	1
R44	RESISTOR 330K 1%	1
R45	RESISTOR 220K 1%	1
R46	RESISTOR 33K 1%	1
R9–20	RESISTOR 15R 1%	12
TS1	RESISTOR NTC 15K	1
TS2	RESISTOR NTC 15K	1
U1	IC PIC16F877-20I-L	1
U2	IC ULN2003	1
U3, 4	IC 4051	2
U5	IC ICL7662CBA	1
U6	IC 7805	1
X3	MALE POST HEADER 1 × 2-POLE STRAIGHT	1
XTAL1	XTAL 8 MHz	1

8.18.2 List of components – Alarm board, rev 5

Reference	Description	Quantity
	CABLE TIE 150 mm	1
	DISTANCE DLCBSTE-7-01	4
	JUMPER SWITCH	1
	LCD DISPLAY PG12232-LRS-ANN-B	1
(CN2)	MALE POST HEADER 1 × 20-POLE	1
(U1)	IC-SOCKET PLCC44	1
(U6)	IC-SOCKET NIT M6M M5	1
BAT1	BATTERY 4.8 V, 70 mAh	1
C1, 2	CAPACITOR 15 pF NP0	2
C3, 4, 7, 9, 10, 11	CAPACITOR 0.1 µF X7R	6
C5	CAPACITOR 10 µF, 16 V	1
C6	CAPACITOR, TANTALUM 1 µF, 20 V	1
C8	CAPACITOR 100 µF, 50 V CV-AX	1
CN1	HEADER CONNECTOR 26-POLE	1
CN3	HEADER CONNECTOR 16-POLE	1
CN4	MALE POST HEADER 1 × 5-POLE	1
D2,3,4	DIODE BAS85	3
D5-14	DIODE BAS32	10
Q1,3-12	TRANSISTOR BC808-40	11
Q2	TRANSISTOR BC817-40	1
R1-8,38,41-43,48	RESISTOR 10k 1%	13
R21-28,35,47	RESISTOR 100R 1%	10
R29,30,32,40	RESISTOR 2k2 1%	4
R31	RESISTOR 10R 1%	1
R33	RESISTOR 1k 1%	1
R34	RESISTOR 470R 1%	1
R36	RESISTOR 220R 1%	1
R37	RESISTOR 47R AC04	1
R39	RESISTOR 3k9 1%	1
R44	RESISTOR 330K	1
R45	RESISTOR 220k 1%	1
R46	RESISTOR 33k 1%	1

Reference	Description	Quantity
R49	RESISTOR 47k 1%	1
R9-20	RESISTOR 15R 1%	12
TS2	RESISTOR NTC 15k	1
U1	IC PIC16F877-20I-L	1
U2	IC ULN2003	1
U3,4	IC 4051	2
U5	IIC CL7662CBA	1
U6	IC 7805UC	1
U7	IC MC33164D-3	1
X3	MALE POST HEADER 1 × 2-POLE	1
XTAL1	XTAL 8 MHz	1

8.18.3 List of components – CPU board, rev 5

Reference	Description	Quantity
(BAT1)	BATTERY CR2032 3 V, 230 mAh	1
(S1)	FUSE T1AL	1
(S2), Q21, D2	POLYFUSE RXE135	1
(S6)	FUSE T5AL	1
BAT1	BATTERY HOLDER VBH2032-1	1
BR1	BRIDGE DF10S	1
C1	CAPACITOR 220 nF PME271	1
C10	CAPACITOR 100 nF, 400 V	1
C11	CAPACITOR 220 pF, 400 V	1
C12, 50, 107, 108, 109	CAPACITOR 10 nF X7R	5
C137, 138	CAPACITOR 2n2 Y1 DE1210E222M	2
C14, 19, 20	CAPACITOR, TANTALUM 1 µF, 50 V	3
C147	CAPACITOR ELYT 220 µF, 10 V MVK	1
C149	CAPACITOR 47 nF, X7R	1
C15, 81, 82	CAPACITOR 2.2 nF X7R	3
C151, 152	CAPACITOR XY 4 n7 400v	2
C16	CAPACITOR 470 pF NP0	1
C18	CAPACITOR 220 pF, 400 V	1
C2	CAPACITOR X 68 nF PME271	1
C21, 22, 31	CAPACITOR ELYT 100 µF, 50 V CV-AX	3
C23	CAPACITOR 47 nF X7R	1
C24, 28, 29, 30	CAPACITOR XY 1 nF, 400v	4
C3, 132	CAPACITOR 1 nF, 400 V	2
C32–34, 41, 42, 46–48, 51	CAPACITOR, TANTALUM 1 µF, 20 V	9
C37	CAPACITOR, TANTALUM 10 µF, 6 V	1
C39	CAPACITOR, TANTALUM 100 µF, 6 V	1
C4	CAPACITOR 100 µF, 400 V	1
C5, 27	CAPACITOR 10 µF, 50 V MVK	2

Reference	Description	Quantity
C6, 9, 13, 17, 25, 26, 35, 36, 38, 40, 43–45, 49, 52–54, 64–72, 74, 75, 77–79, 84–89, 91–97, 100–106, 110, 113–127, 131, 133, 135, 13, 6, 139–146, 153	CAPACITOR 100 nF X7R	80
C7, 8	CAPACITOR 1000 µF, 50 V	2
C76	CAPACITOR 330 pF NP0	1
C80, 83	CAPACITOR 470 µF, 50V	2
C90	CAPACITOR 68 nF X7R	1
C98, 99, 111, 112, 128–130, 134	CAPACITOR 1 nF NP0	8
CN1	CONNECTOR AMP MTA100 3-POLE	1
CN2	CONNECTOR AMP 9-POLE	1
CN3	CONNECTOR AMP 8-POLE	1
CN4	CONNECTOR AMP MTA100 2-POLE	1
CN5	HEADER CONNECTOR 26-POLE EJECTOR	1
CN6	HEADER CONNECTOR 20-POLE EJECTOR	1
CN7	HEADER CONNECTOR 16-POLE EJECTOR	1
CN8	HEADER CONNECTOR 16-POLE	1
D1, 3, 6, 9-13, 18, 31–33, 35, 36, 41, 46, 47	DIODE BAS21	17
D15	DIODE 20ETF04S	1
D19, 42, 43	DIODE SM4004	3
D2, 45	DIODE BYG90-40	2
D20, 21, 22, 26, 27	DIODE 50WQ04FN	5
D24	ZENER DIODE BZX84C5V6	1
D29	ZENER DIODE BZX84C4V7	1
D30	TRANSIL SM6T6V8A	1
D34	DIODE 6A1	1
D39, 40	DIODE BAV70	2
D4, 5, 37, 38	ZENER DIODE BZV49-C6V2	4
D44	DIODE BAT54	1
D7, 14, 16, 17	DIODE BYD37M	4
D8, 28	DIODE BAS85	2

Reference	Description	Quantity
L1	INDUCTOR 22 µH	1
L2	INDUCTOR 220 µH	1
L3	INDUCTOR 330 µH KM5	1
L4, 5	INDUCTOR 330 µH	2
Q1	TRANSISTOR BC817-16	1
Q18, 22, 24	TRANSISTOR BC817-40	3
Q2, 11, 12, 13, 15, 21, 26	TRANSISTOR MTD20P06HDL	7
Q23	TRANSISTOR BC808	1
Q27, 28	TRANSISTOR PDTC144ET	2
Q3, 5, 14, 16, 20	TRANSISTOR PMBF170	5
Q4, 8, 10, 17	TRANSISTOR MTD20N06HDL	4
Q6, 9, 19	TRANSISTOR BC807-40	3
Q7	TRANSISTOR MTB6N60E	1
R1	RESISTOR NTC B57236-S200-M	1
R10	RESISTOR 39K 1%	1
R100	RESISTOR 2K2 0.6 W	1
R11, 113, 134, 139	RESISTOR 3K3 1%	4
R115, 120, 148	RESISTOR 6K8 1%	3
R121	RESISTOR 33K	1
R124, 135, 137	RESISTOR 2K2 1%	3
R14	RESISTOR 270R 1%	1
R141	NTC 10K B57621C103	1
R144	RESISTOR 680R 1%	1
R15, 43, 45, 78	RESISTOR 10R 1%	4
R16	RESISTOR 1K 1%	1
R17	RESISTOR 1M 0.6 W	1
R18	VARISTOR S14K300	1
R2, 117	RESISTOR 220K 0.6 W	2
R22, 31, 32, 44, 57, 97	RESISTOR 100K 1%	6
R23, 36, 51, 54, 56, 58, 67, 75, 85, 102, 105, 106, 111, 112, 114, 116, 119, 126–133	RESISTOR 1K 1%	25

Reference	Description	Quantity
R24, 107, 108, 109, 110	RESISTOR 47R 1%	5
R25, 61, 62, 63, 99, 101	RESISTOR 22K 1%	6
R26	RESISTOR 33R 1%	1
R27, 28	RESISTOR 1R 1 W	2
R29	RESISTOR 4K7 2 W	1
R3, 5, 20, 21, 65, 70, 79, 80, 82, 86, 87, 92, 118, 125, 143	RESISTOR 4K7 1%	15
R30, 33, 34, 37, 40, 42, 47–50, 66, 69, 71, 73, 74, 83, 84, 94, 88, 89, 140, 142, 145–147, 149	RESISTOR 10K 1%	21
R35	RESISTOR 0R1 1 W	1
R38		1
R4, 19, 96	RESISTOR 270K 1%	3
R41, 68, 59, 122, 123, 136	RESISTOR 100R 1%	6
R46, 52, 53, 55, 76, 77	RESISTOR 22R 1%	6
R6	RESISTOR 5K6 2 W	1
R60, 138	RESISTOR 220R 1%	2
R64	RESISTOR 27K 1%	1
R7	RESISTOR 1K 0.6 W	1
R72	RESISTOR 390R 1%	1
R8	RESISTOR 5K6 1%	1
R81	RESISTOR 22R 1%	1
R9, 98	RESISTOR 47K 1%	2
R95	RESISTOR 12K 1%	1
S1, 6	FUSE HOLDER OGN 0031.8201	2
S2	RESISTOR PTC RXE300	1
S3	PICOFUSE 0.75 A 251.750	1
S4	PICOFUSE 0.125 A 251.125	1
TR1	INDUCTOR PLAA 7 µH	1
TR2	TRANSFORMER ETD34-3F3	1
U1	IC UC3845D	1

Reference	Description	Quantity
U11	IC DS1302	1
U12	IC DS1811B	1
U13	IC REF02	1
U14	IC NC7S08	1
U15	IC NC7S32	1
U16	IC MAX4514	1
U17, 18	IC 4051	2
U19	IC LM2576S-5.0	1
U2	IC 74HC14	1
U20	IC LM2575S-12	1
U21	IC MAX4514	1
U22	IC 74HC00	1
U24	IC 74HC393	1
U3, 5, 23	IC LM358Y	3
U4	IC LM393	1
U6	IC 628128	1
U7	IC AM29F010A-120JC	1
U8	IC M30620SFP	1
U9	IC DS14C232	1
X1	X-TAL 32.768 kHz	1
X2	X-TAL 16 MHz CSTCA_MXA_Q	1

8.18.4 List of components – CPU board, rev 6

Reference	Description	Quantity
(BAT)	BATTERY CR2032 3V	1
(S1)	FUSE 1A T 5x20mm	1
(S6)	FUSE 5AT 5x20mm	1
BAT1	BATTERY HOLDER VBH2032-1	1
BR1	BRIDGE DF10S	1
C1	CAPACITOR 220nF PME271	1
C10	CAPACITOR 100nF/400V	1
C11	CAPACITOR 220pF 500V	1
C12, 50, 107-109, 125-127	CAPACITOR 10nF X7R	8
C137, 138	CAPACITOR 2,2nF Y1 DE1210E222M	2
C14, 19, 20	CAPACITOR 1µF 50V	3
C147	CAPACITOR 220u/10V CV-AX	1
C148	CAPACITOR 22pF NPO	1
C149	CAPACITOR 47nF X7R	1
C15, 81, 82	CAPACITOR 2,2nF X7R	3
C150	CAPACITOR 47µF/16V SMD ELYT	1
C151, 152	CAPACITOR 4,7nF 500V XY	2
C16	CAPACITOR 150pF/50V	1
C18	CAPACITOR 220pF 400V	1
C2	CAPACITOR 68nF PME271	1
C21, 22, 31	CAPACITOR 100µF 50V CV-AX	3
C23	CAPACITOR 2,2nF X7R	1
C24, 28, 29, 30	CAPACITOR 1nF/400V	4
C3, 132	CAPACITOR 1nF/400V	2
C32-34, 41, 42, 46, 47, 48, 51	CAPACITOR 1µF/20V	9
C37	CAPACITOR 10µF/6V	1
C39	CAPACITOR 100µF/16V	1
C4	CAPACITOR 100µF 400V	1
C5, 27	CAPACITOR 10µF/50V MVKF55	2

Reference	Description	Quantity
C6, 9, 17, 25, 26, 35, 36, 38, 40, 43-45, 49, 52-54, 64-72, 74, 75, 77-79, 84-89, 91-97, 100-106, 110, 113-124, 131, 133, 135, 136, 139-146, 153, 154	CAPACITOR 100nF X7R	77
C7, 8	CAPACITOR 1000µF 50V 105GR	2
C73	CAPACITOR 5,6pF NP0	1
C76	CAPACITOR 330pF NPO	1
C80, 83	CAPACITOR 470µF 50V	2
C90	CAPACITOR 68nF X7R	1
C98, 99, 111, 112, 128-130, 134	CAPACITOR 1nF NPO	8
CN1	CONNECTOR 3-POLE	1
CN2	CONNECTOR 9-POLE	1
CN3	CONNECTOR 8-POLE 0	1
CN4	CONNECTOR 2-POLE	1
CN5	HEADER CONNECTOR 26-POLE EJECTOR	1
CN6	HEADER CONNECTOR 20-POLE EJECTOR	1
CN7	HEADER CONNECTOR 16-POLE EJECTOR	1
CN8	HEADER CONNECTOR 16-POLE	1
CN9	CONNECTOR 2-POLE	1
D1, 3, 6, 9-13, 18, 31-33, 35, 36, 41, 46, 47	DIODE BAS21	15
D15	DIODE 20ETF04S	1
D19, 42, 43	DIODE SM4004	3
D2, 45	DIODE BYS10-45	2
D20-22, 26-27	DIODE 50WQ04FN	5
D24	DIODE BZX84C5V6	1
D29	DIODE BZX84C4V7	1
D30	DIODE SM6T6V8A	1
D34	DIODE 60S1/6A1	1
D39, 40	DIODE BAV70	2
D4, 5, 37, 38	DIODE BZV49-C6V2	4
D44	DIODE BAT54	1
D48, 49	DIODE BZX84C12	2

Reference	Description	Quantity
D7, 14, 16, 17	DIODE BYD37M	4
D8, 28	DIODE BAS85	2
L1	INDUCTOR 22 µH 220K	1
L2	INDUCTOR 220 µH 221K	1
L3	INDUCTOR 330 µH KM5	1
L4, 5	INDUCTOR 330 µH 331K	2
Q1, 18, 22, 24, 25, 29	TRANSISTOR BC817-40	6
Q2, 11-13, 15, 21, 26	TRANSISTOR MTD20P06HDL	7
Q27, 28	TRANSISTOR PDTC144ET	2
Q3, 5, 14, 16, 20	TRANSISTOR PMBF170	5
Q4, 8, 10, 17	TRANSISTOR MTD20N06HDL	4
Q6, 9, 19, 23	TRANSISTOR BC807-40	4
Q7	TRANSISTOR MTB6N60E	1
R1	RESISTOR B57236-S200-M	1
R10	RESISTOR 39K 1%	1
R100	RESISTOR 680R 2W	1
R107-110	RESISTOR 47R 1%	4
R11	RESISTOR 8K2 1%	1
R12, 30, 33, 34, 37, 40, 42, 47-50, 57, 66, 69, 71, 73, 74, 83, 84, 94, 88, 89, 140, 142, 145-147, 149	RESISTOR 10k 1%	28
R121	RESISTOR 33k 1%	1
R14	RESISTOR 270R 1%	1
R141	NTC 10k B57621C103	1
R15, 43, 45, 78	RESISTOR 10R 1%	4
R151	RESISTOR 56R 1%	1
R153	RESISTOR 24K9	1
R16	RESISTOR 1k 1%	1
R17	RESISTOR 1M 1W	1
R18	VARISTOR S14K300	1
R2, 117	RESISTOR 220k 0,6W	2
R22, 31, 32, 44, 87, 97, 152	RESISTOR 100k 1%	7

Reference	Description	Quantity
R23, 36, 56, 58, 67, 93, 85, 102-104, 106, 111, 112, 114, 116, 119, 126-133, 156	RESISTOR 1k 1%	25
R24, 144	RESISTOR 680R 1%	2
R25, 61-63, 99, 101, 105, 158	RESISTOR 22k 1%	8
R26	RESISTOR 33R 1%	1
R27, 28	RESISTOR 0R68 1W	2
R29	RESISTOR 4K7 2W	1
R3, 5, 20, 21, 39, 70, 79, 80, 82, 86, 90-92, 118, 125, 143, 157	RESISTOR 4k7 1%	17
R35	RESISTOR 0R1 1W	1
R4, 19, 96	RESISTOR 270k 1%	3
R41, 59, 68, 122, 123, 136	RESISTOR 100R 1%	6
R46, 52, 53, 55, 76, 77	RESISTOR 22R 1%	6
R51, 54, 75	RESISTOR 330R	3
R6	RESISTOR 5K6 2W	1
R60, 138, 155	RESISTOR 220R 1%	3
R64	RESISTOR 27K 1%	1
R65, 113, 134, 139	RESISTOR 3k3 1%	4
R7	RESISTOR 1k 0,6W	1
R72, 124, 135, 137, 154	RESISTOR 2k2 1%	5
R8, 115, 120, 148, 150	RESISTOR 6K8 1%	5
R81	RESISTOR 10R 1%	1
R9, 13, 98	RESISTOR 47k 1%	3
R95	RESISTOR 12K 1%	1
S1, 6	FUSE HOLDER	2
S2	RXE300 PTC	1
S3	PICOFUSE 0.75 A	1
S4	PICOFUSE 0.125 A	1
S5	RXE135	1
TR1	INDUCTOR PLAA 7 µH	1
TR2	TRANSFORMER ETD34-3F3	1

Reference	Description	Quantity
U1	IC UC 3845D	1
U10	IC CNY17F-3	1
U11	IC DS1302Z	1
U12	IC DS1811-5	1
U13	IC REF02	1
U14	IC NC7S08	1
U15	IC NC7S32	1
U16	IC MAX4514	1
U17, 18	IC 4051	2
U19	IC LM2576S-5.0	1
U2	IC 74HC14	1
U20	IC LM2575S-12	1
U22	IC 74HC00	1
U24	IC 74HC393	1
U25	IC TL431CA	1
U3, 5, 23	IC LM358D	3
U4	IC LM393D	1
U6	IC 628128	1
U7	IC 29F010A-120JC	1
U8	IC M30620SFP	1
U9	IC DS14C232	1
X1	X-TAL 32768Hz	1
X2	X-TAL 16MHz CSTCA MXA	1

8.18.5 List of components – CPU board, rev 7B

Reference	Description	Quantity
(BAT)	BATTERY CR2032 3V	1
(J1,2)	SHUNT 2,54	2
(S1)	FUSE 1A T 5x20mm	1
(S6)	FUSE 5AT 5x20mm	1
BAT1	BATTERY HOLDER VBH2032-1	1
BR1	BRIDGE DF10S	1
C1	CAPACITOR 220nF PME271	1
C10	CAPACITOR 100nF/400V	1
C11	CAPACITOR 220pF 500V	1
C12, 50, 107-109, 125-127	CAPACITOR 10nF X7R	8
C137, 138	CAPACITOR 2,2nF Y1 DE1210E222M	2
C14, 19, 20	CAPACITOR 1µF 50V	3
C147	CAPACITOR 220µF/10V CV-AX	1
C148	CAPACITOR 22pF NPO	1
C149	CAPACITOR 47nF X7R	1
C15, 81, 82	CAPACITOR 2,2nF X7R	3
C150	CAPACITOR 47µF/16V SMD ELYT	1
C151, 152	CAPACITOR 4,7nF 500V XY	2
C16	CAPACITOR 150pF/50V	1
C18	CAPACITOR 220pF 400V	1
C2	CAPACITOR 68nF PME271	1
C21, 22, 31	CAPACITOR 100µF 50V CV-AX	3
C23	CAPACITOR 2,2nF X7R	1
C24, 28, 29, 30	CAPACITOR 1nF/400V	4
C3, 132	CAPACITOR 1nF/400V	2
C32-34, 46, 47	CAPACITOR 1µF/20V	5
C37	CAPACITOR 10µF/6V	1
C39	CAPACITOR 100µF/16V	1
C4	CAPACITOR 100µF 400V	1
C5, 27	CAPACITOR 10µF/50V MVKF55	2

Reference	Description	Quantity
C6, 9, 17, 25, 26, 35, 36, 38, 40-45, 48, 51-54, 64-72, 74, 75, 77-79, 84-89, 91-97, 100-106, 110, 113-124, 131, 133, 135, 136, 139-146, 153, 154, 156-160	CAPACITOR 100nF X7R	80
C7, 8	CAPACITOR 1000µF 50V 105GR	2
C73	CAPACITOR 5,6pF NP0	1
C76	CAPACITOR 330pF NPO	1
C80, 83	CAPACITOR 470µF 50V	2
C90	CAPACITOR 68nF X7R	1
C98, 99, 111, 112, 128-130, 134	CAPACITOR 1nF NPO	8
CN1	CONNECTOR 3-POLE	1
CN10	CONNECTOR 4-POLE	1
CN2	CONNECTOR 9-POLE	1
CN3	CONNECTOR 8-POLE	1
CN4	CONNECTOR 2-POLE	1
CN5	HEADER CONNECTOR 26-POLE EJECTOR	1
CN6	HEADER CONNECTOR 20-POLE EJECTOR	1
CN7	HEADER CONNECTOR 16-POLE EJECTOR	1
CN8	HEADER CONNECTOR 16-POLE	1
CN9	CONNECTOR 2-POLE	1
D1, 3, 6, 9-13, 18, 23, 31-33, 35, 36, 41, 47	DIODE BAS21	15
D15	DIODE 20ETF04S	1
D19, 42, 43	DIODE SM4004	3
D2, 45	DIODE BYS10-45	2
D20-22, 26-27	DIODE 50WQ04FN	5
D24	DIODE BZX84C5V6	1
D29	DIODE BZX84C4V7	1
D30	DIODE SM6T6V8A	1
D34	DIODE 60S1/6A1	1
D39, 40	DIODE BAV70	2
D4, 5, 37, 38	DIODE BZV49-C6V2	4
D44	DIODE BAT54	1

Reference	Description	Quantity
D48, 49	DIODE BZX84C12	2
D7, 14, 16, 17	DIODE BYD37M	4
D8, 28	DIODE BAS85	2
J1, 2	MALE POST HEADER 1 x 2 POLE	2
L1	INDUCTOR 22 µH 220K	1
L2	INDUCTOR 220 µH 221K	1
L3	INDUCTOR 330 µH KM5	1
L4, 5	INDUCTOR 330 µH 331K	2
Q1, 18, 22, 24, 25, 29	TRANSISTOR BC817-40	6
Q2, 11-13, 15, 21, 26	TRANSISTOR MTD20P06HDL	7
Q27, 28, 30, 31	TRANSISTOR PDTC144ET	4
Q3, 5, 14, 16, 20, 33	TRANSISTOR PMBF170	6
Q4, 8, 10, 17	TRANSISTOR MTD20N06HDL	4
Q6, 9, 19, 23, 32	TRANSISTOR BC807-40	5
Q7	TRANSISTOR MTB6N60E	1
R1	RESISTOR NTC B57236-S200-M	1
R10	RESISTOR 39K 1%	1
R100	RESISTOR 680R 2W	1
R107-110, 161	RESISTOR 47R 1%	5
R11	RESISTOR 8K2 1%	1
R117	RESISTOR 220k 1%	1
R12, 30, 33, 34, 37, 40, 42, 47-50, 57, 66, 69, 71, 73, 74, 83, 84, 94, 88, 89, 140, 142, 145-147, 149, 162, 163, 164	RESISTOR 10k 1%	31
R121	RESISTOR 33k 1%	1
R14	RESISTOR 270R 1%	1
R141	NTC 10k B57621C103	1
R15, 43, 45, 78	RESISTOR 10R 1%	4
R151	RESISTOR 56R 1%	1
R153	RESISTOR 24K9	1
R16	RESISTOR 1k 1%	1
R17	RESISTOR 1M 1W	1
R18	VARISTOR S14K300	1

Reference	Description	Quantity
R2	RESISTOR 220k 0,6W	1
R22, 31, 32, 44, 87, 97, 152, 165	RESISTOR 100k 1%	7
R23, 36, 56, 58, 67, 93, 85, 102-104, 106, 111, 112, 114, 116, 119, 126-133, 156, 166	RESISTOR 1k 1%	26
R24, 144	RESISTOR 680R 1%	2
R25, 61-63, 99, 101, 105, 158	RESISTOR 22k 1%	8
R26	RESISTOR 33R 1%	1
R27, 28	RESISTOR 0R68 1W	2
R29	RESISTOR 4K7 2W	1
R3, 5, 20, 21, 39, 70, 79, 80, 82, 86, 90-92, 118, 125, 143, 157	RESISTOR 4k7 1%	17
R35	RESISTOR 0R1 1W	1
R4, 19, 96	RESISTOR 270k 1%	3
R41, 59, 68, 122, 123, 136, 159, 160	RESISTOR 100R 1%	8
R46, 52, 53, 55, 76, 77	RESISTOR 22R 1%	6
R51, 54, 75	RESISTOR 330R	3
R6	RESISTOR 5K6 2W	1
R60, 138, 155	RESISTOR 220R 1%	3
R64	RESISTOR 27K 1%	1
R65,113,134,139	RESISTOR 3k3 1%	4
R7	RESISTOR 1k 0,6W	1
R72,124,135,137,154	RESISTOR 2k2 1%	5
R8,115,120,148,150	RESISTOR 6K8 1%	5
R81	RESISTOR 10R 1%	1
R9,13,98	RESISTOR 47k 1%	3
R95	RESISTOR 12K 1%	1
S1, 6	FUSE HOLDER	2
S2	RXE300 PTC	1
S3	PICOFUSE 0.75 A	1
S4	PICOFUSE 0.125 A	1

Reference	Description	Quantity
S5	RXE135	1
TR1	INDUCTOR PLAA 7 µH	1
TR2	TRANSFORMER ETD34-3F3	1
U1	IC UC 3845D	1
U10	IC CNY17F-3	1
U11	IC DS1302Z	1
U12	IC DS1811-5	1
U13	IC REF02	1
U14	IC NC7S08	1
U15	IC NC7S32	1
U16	IC MAX4514	1
U17,18	IC 4051	2
U19	IC LM2576S-5.0	1
U2	IC 74HC14	1
U20	IC LM2575S-12	1
U22	IC 74HC00	1
U24	IC 74HC393	1
U25	IC TL431CA	1
U3, 5, 23	IC LM358D	3
U4	IC LM393D	1
U6	IC 628128	1
U7	IC 29F010A-120JC	1
U8	IC M30620SFP	1
U9	IC DS14C232	1
X1	X-TAL 32768Hz	1
X2	X-TAL 16MHz CSTCA MXA	1

8.18.6 List of components – I/O board, rev A

Reference	Description	Quantity
	DISTANCE DRM3260x8	2
	DISTANCE DSUB	1
	LABEL SERIAL NUMBER	1
	PCB	1
(CN2–CN3)	RIBBON CABLE 20-POLE	1
(J1, 2)	JUMPER SWITCH	2
C1–7	CAPACITOR 0.1 µF, 50 V X7R	7
CN1	CONNECTOR DSUB25P STRAIGHT PC	1
CN2	CONNECTOR PCB SOLDER 2 × 10-POLE	1
CN3	SOCKET CONNECTOR 2 × 10-POLE	1
D1, 5	ZENER DIODE BZX84C4V7	2
D2	DIODE 1N4148	1
D3, 4	TRANSIL SM6T15CA	2
J1, 2	MALE POST HEADER 1 × 3-POLE ANGLED	2
K1	RELAY 12 V 4KV CUPV10302	1
P1	POTENTIOMETER 500R 1-TURN 72P	1
PZ1	BUZZER QFP03A	1
Q1	TRANSISTOR BC817-40	1
R1	RESISTOR 47R 1%	1
R12	RESISTOR 2K2 1%	1
R2, 3, 11	RESISTOR 100R 1%	3
R4, 6, 7, 9	RESISTOR 1K 1%	4
R5, 8, 10	RESISTOR 10K 1%	3
RF1	FERRITE 4330-030-3630	1
RF2	FERRITE 25-POLE DSUB	1
VR1	POLYFUSE RXE 040	1
VR2	POLYFUSE RXE 010	1

8.18.7 List of components – I/O board, rev 2

Reference	Description	Quantity
	DISTANCE DRM3260x8	2
	DISTANCE DSUB	1
	LABEL SERIAL NUMBER	1
	PCB	1
(J1, 2)	JUMPER SWITCH	2
C1–7	CAPACITOR 0.1 µF, 50 V X7R	7
CN1	CONNECTOR DSUB25P MALE PC	1
D1, 6	DIODE BZX84C4V7	2
D2	DIODE 1N4148	1
D3, 4	DIODE SM6T15CA	2
D5	DIODE SM6T6V8A	1
J1, 2	MALE POST HEADER 1 × 3-POLE ANGLED	2
K1	RELAY 12 V 4KV CUPV10302	1
P1	POTENTIOMETER 500R 1-TURN	1
PZ1	BUZZER QFP03A	1
Q1	TRANSISTOR BC817-40	1
R1	RESISTOR 47R 1%	1
R12	RESISTOR 2k2 1%	1
R13	RESISTOR 47R 1%	1
R2, 3, 11	RESISTOR 100R 1%	3
R4, 6, 7, 9	RESISTOR 1k 1%	4
R5, 8, 10	RESISTOR 10k 1%	3
RF1	FERRIT 4330-030-3630	1
RF2	FERRIT 25p DSUB	1
VR1	POLYFUSE RXE 040	1
VR2	POLYFUSE RXE 010	1

8.18.8 List of components – PGC board, rev 4

Reference	Description	Quantity
	ABSORBENT + ADHESIVE, part no. 002137	1
	LABEL SERIAL NUMBER	1
	NIPPLE CN-M5-PK3	1
	NUT M6M M5	1
	PCB	1
	RUBBER FEED THROUGH	3
	SCREW MFXZ 3 × 6 STEEL FZB	3
	TUBE 2.5 × 6 BLUE, part no. 000566	3
(CN1)	RIBBON CABLE 26-POLE	1
(CN1)	SOCKET CONNECTOR 2 × 13-POLE	1
(F1)	FUSE S3, 15AL	1
(Q4)	HEATSINK	1
C1, 2, 8, 12, 13	CAPACITOR, TANTALUM 1 µF, 20 V	5
C10	CAPACITOR 0.1 µF X7R 50 V	1
C14, 16	CAPACITOR 1 nF X7R 50 V	2
C15	CAPACITOR, TANTALUM 4.7 µF, 16 V	1
C3, 4	CAPACITOR 10 nF X7R 50 V	2
C5, 6	CAPACITOR 470 pF NP0 50 V	2
C7, 11	CAPACITOR ELYT 1 µF, 50 V	2
C9	CAPACITOR ELYT 100 µF, 50 V CV-AX	1
CN1	CONNECTOR PCB SOLDER 26-POLE	1
CN2	CONNECTOR 3-POLE ANGLED	1
D1-3	DIODE SM4004	3
D4	DIODE 6A1	1
DZ1	ZENER DIODE BZX84C36	1
F1	FUSE HOLDER OGN 0031.8201	1
G1, 2	PRESSURE SENSOR PPXV5007	2
MV1, 2	MAGNET VALVE 11-18-3-BV-24P	2
NTC1	NTC 10K B57621C103	1
P1	POTENTIOMETER 20K 64 W	1
P2	POTENTIOMETER 5K 64 W	1
Q1, 2, 5	TRANSISTOR BC817-40	3

Reference	Description	Quantity
Q3	TRANSISTOR BC808-25	1
Q4	TRANSISTOR TIP42C	1
R1, 2, 7, 11, 14, 17, 23	RESISTOR 10K 1%	7
R10, 25	RESISTOR 1K 1%	2
R15, 20	RESISTOR 24K 1%	2
R16, 22	RESISTOR 220K 1%	2
R18	RESISTOR 22K 1%	1
R19	RESISTOR 3K9 1%	1
R21	RESISTOR 5K1 1%	1
R24	RESISTOR 47K 1%	1
R26	RESISTOR 1K82 1%	1
R3, 4, 12, 13	RESISTOR 2K2 1%	4
R5, 6	RESISTOR 51K 1%	2
R8	RESISTOR 1R8 1W	1
R9	RESISTOR 100R 1%	1
S1	POLYSWITCH RXE050	1
U1	IC 7805	1
U2	THYRISTOR BT148-600R	1
U3	IC 7812	1
U4	IC LM324Y	1
X1	MALE POST HEADER 1 × 10-POLE ANGLED	1
X2	AIRFLOW SENSOR AWM2100V	1

8.18.9 List of components – PGC board, rev 6B

Reference	Description	Quantity
	ABSORBENT (PV403 PGC)	1
	RUBBER FEED THROUGH	3
	M6M-8 M5 DIN934 fzb	1
	NUT M6M M5	1
	NIPPLE R CN-M5-PK-3	1
	RTS 2,9x16 fzb	3
	TUBE BLUE 6mm (PV403 PGC)	3
	SOCKET CONNECTOR 3-POLE	1
(F1)	FUSE 3,15AF	1
(Q4)	HEATSINK	1
C1, 2, 8, 20	CAPACITOR 1µF/20V	4
C10, 17, 18, 22-34, 156-160	CAPACITOR 100nF X7R	20
C3, 4, 19, 35	CAPACITOR 10nF X7R	4
C5, 6, 21	CAPACITOR 470pF NPO	3
C7	CAPACITOR 1µF/50V	1
C9	CAPACITOR 100µF 50V CV-AX	1
CN11	CONNECTOR 4-POLE	1
CN12	CONNECTOR 2-POLE	1
D1-3, 5	DIODE SM4004	4
D4	DIODE 60S1/6A1	1
F1	FUSE HOLDER	1
G1, 2	PRESSURE SENSOR PPXV5007	2
G3	PRESSURE SENSOR MPXV5004GC6U	1
MV1, 2, 3	MAGNET VALVE 11-18-3-BV-24	3
NTC1	NTC 10k B57621C103	1
Q1, 2, 5, 6	TRANSISTOR BC817-40	4
Q3	TRANSISTOR BC808-40	1
Q4	TRANSISTOR TIP42C	1
Q7	TRANSISTOR BCP54-16VL	1
R1, 2, 7, 11, 27-29	RESISTOR 10k 1%	7
R10	RESISTOR 1k 1%	1

Reference	Description	Quantity
R3, 4, 12-14	RESISTOR 2k2 1%	5
R5, 6, 30	RESISTOR 51k 1%	3
R8	RESISTOR 1R8 1W	1
S1, 2	POLYSWITCH RXE050	2
U1	IC 7805UC	1
U5	IC LM358D	1

8.18.10 List of components – Push-button membrane panel

Reference	Description	Quantity
	PCB	1
CN1	MALE POST HEADER 2 × 13-POLE STRAIGHT	1
D1–40, 44, 48	LED 9CCL170G-CD	42
D41	LED 8CCL155Y/PG	1
D42, 43, 45, 47	LED 9CCL170HR-CD	4
D46	LED 9CCL170Y-CD	1
SW1–7	SWITCH MEMBRANE STEEL	7

8.18.11 List of components – Rear panel

Position	Description	Quantity
1	REAR PANEL, part no. 001923	1
2	PCB I/O, part no. 001905	1
3		
4	AC INLET CLASS 2 6102.5220	1
5	CONNECTOR 3-POLE XLR 7000	1
6		
7	CONNECTOR BNC CHASSIS FEMALE	1
8	SOLDER EAR	1
9	ISOLATING PANEL BNC	1
10		
11	CABLE AWG20 RED, L = 300 mm	1
12	CABLE AWG20 BLACK, L = 300 mm	1
13	CABLE PTFE-M-EE2219, L = 50 mm	2
14	CABLE 0.75 mm 2 RK RED, L = 150 mm	2
15	CONNECTOR 4.8 × 0.8 RED	2
16	CONNECTOR MTA100 3-POLE ORANGE	1
17	CONNECTOR MTA100 2-POLE YELLOW	1
18		
19	SHRINK TUBE 3.2 mm BLACK, L = 20 mm	2
20		
21	DISTANCE DRM3260 × 7	5
22	NUT M3 WITH LOCKING	5
23		
24	CABLE TIE 100 mm	5
25		
26	OVERLAY PANEL, part no. 001922	1
27		
28	SCREW MFXZ 3 × 6 STEEL FZB, L = 20 mm	4

8.18.12List of components – Cables

Position	Description	Quantity
1	ALARM/OVERLAY PCB CABLE	
2		
3	CONNECTOR FEMALE SOCKET 2 × 13-POLE	2
4	RIBBON CABLE 26-POLE, 50 mm	
5		
6		
7	CPU/ALARM PCB CABLE	
8		
9	CONNECTOR FEMALE SOCKET 2 × 8-POLE	2
10	RIBBON CABLE 16-POLE, 140 mm	
11	FERRITE 2643 1638 51	1

9 Fault tracing

This chapter contains a fault-tracing table and a table of error codes to use when trouble-shooting the PV 403.

9.1 Fault tracing table

If the PV 403 does not work properly try to identify the problem in the table below. Check the possible causes and carry out the suggested remedial actions.

Symptom	Possible cause	Remedial action	See ref.
Ventilator does not start.	• Power cord not properly connected.	• Connect power cord.	2.4.2
	• Mains fuse blown.	• Replace CPU board.	5.4
Ventilator does not run from external battery supply.	• External batteries discharged.	• Charge external batteries.	8.10/2.6.9/ Chapter 17 in PV 403 Operating Manual
	• External battery cable not connected properly or faulty.	**1** Connect cable. **2** If cable connected, measure voltage. **3** Replace cable if faulty.	8.10/2.6.9/ Chapter 17 in PV 403 Operating Manual
	• External battery fuse on CPU board blown.	• Replace fuse.	8
	• Battery polarity faulty. May be the case if fuse blows immediately after connecting to external battery cable.	• Check polarity.	8
	• Voltage faulty.	**1** Measure voltage between pins in CN4 with battery connected. Voltage should be approximately 24 V DC. **2** If no voltage, check wiring and filter board. **3** Replace if faulty.	8
Ventilator does not give adequate pressure/volume.	• External leaks from patient circuit or nasal mask.	• Check tubes, mask, and exhalation valve for leaks.	2.6.11
	• Internal leaks from tubes, bellows or check valves.	• Perform internal leakage test.	6.6
	• Air filters dirty.	**1** Replace white filter. **2** Wash grey filters.	2.6.15

Symptom	Possible cause	Remedial action	See ref.
	• If the ventilator has the optional internal PEEP function, this function may have been activated or switched off without your knowledge.	• Check the PEEP function.	Chapter 11 in PV 403 Operating Manual
Pressure indicator shows no pressure reading.	• Internal supply tube blocked.	• Check tubes and connectors.	
	• PGC board faulty.	**1** Measure at test points CN8 and PIN16 on CPU board. Voltage should be approximately 0.7 V at 0 mbar and 3.5 V at 40 mbar. **2** If voltage not OK, replace PGC board.	8.7, 5.6
	• CPU board faulty.	**1** Check P-SUB outlet PIN16 (earth). Voltage should be approximately 1 V at 0 mbar and 3 V at 40 mbar (0.5 V at 10 mbar). **2** If voltage not OK, replace CPU board.	8.7, 5.4
	• Alarm board faulty.	• Replace alarm board.	5.3
	• Push-button membrane panel faulty.	• Replace push-button membrane panel.	5.2

9.2 Error codes

The PV 403 ventilator contains an error-code memory that can store the last 20 error codes that have been generated. These codes provide useful information when tracing faults or carrying out service work on the ventilator.

9.2.1 Reading the error codes

1 Press and hold the **–** button.

2 Start the ventilator keeping the **–** button pressed.

3 The display will now show the message **FAIL MEM. PUSH FUNC TO SHOW**.

4 Press the **Function** button. The latest error code stored is shown first. The information given is **YEAR, MONTH, DAY, HOUR, MINUTE**, the text **FAIL**, and the error code itself (see below for explanations).

5 Press the **Function** button to scroll back through the error codes to the earliest code stored. After the last code has been displayed the message **SHOW FAIL RDY** is shown.

6 Switch off the ventilator.

9.2.2 Error code table

The table below lists each error code and the corresponding text that is shown on the LCD display. The problem is explained together with the action that is necessary to correct the problem.

If more than one action is listed, the actions should be performed in the order in which they are listed. For example, if action no. 1 does not solve the problem you should continue with action no. 2, and so on.

See chapter 5 “Removing and replacing the main components” for information about how to replace the circuit boards.

Error code	Text on LCD display	Problem	Action
01	ALARM PROC. RAM FAIL	Ventilator fails PIC processor’s internal RAM self-test.	• Replace alarm board.
02	ALARM PROC. FLASH FAIL	Ventilator fails PIC processor’s internal PROM self-test.	• Replace alarm board.
03 (Audible alarm, duration 5 s)	LED FAIL LED#: XX	One or more indicator LEDs faulty. Number (XX) of defective LED shown on LCD display. Problem does not cause function failure; operation will continue after alarm.	**1** Replace settings panel keyboard. **2** Replace alarm board.
04	CPU COM FAIL	Ventilator fails CPU communication test.	• Replace CPU board.
07	PUSH-BUTTN FAIL	Keyboard push-buttons are stuck.	• Replace settings panel keyboard.
11	CPU PROC. RAM FAIL	Ventilator fails CPU processor’s internal RAM self-test.	• Replace CPU board.
12	CPU PROC. FLASH FAIL	Ventilator fails CPU flash PROM’s self-test.	• Replace CPU board.

Error code	Text on LCD display	Problem	Action
13 (Audible alarm, duration 5 s)	CPU NVRAM FAIL. DEF-AULT PARAM SET	Ventilator fails NVRAM's settings parameters self-test. In event of checksum failure default values should be loaded and stored in NVRAM with a correct checksum. Problem does not cause function failure; operation will continue after alarm. Default values for settings parameters: Mode = PSV, (SIMV off) Pressure = 15 mbar Frequency = 8 BPM Inspiration time = 1.5 seconds Inspiration trigger = –0.5 mbar Plateau = 5 Expiration trigger = 25% Volume = 0.4 litres Low pressure alarm = 40 mbar High pressure alarm = 10 mbar Low tidal volume alarm = 1.4 litres High rate alarm = OFF	**1** Replace clock battery on CPU board. **2** Replace CPU board.
14	GAUGE G1 FAIL	Ventilator fails G1 pressure sensor self-test.	**1** If operating temperature of ventilator is between 5°C and 40°C when error occurs, replace PGC board. **2** Replace CPU board.
15	GAUGE G2 FAIL	Ventilator fails G2 pressure sensor self-test.	**1** If operating temperature of ventilator is between 5°C and 40°C when error occurs, replace PGC board. **2** Replace CPU board.
16	CPU PROC. A-D FAIL	Ventilator fails CPU processor and reference-voltage regulator's internal A/D converter self-test. Voltage should be 5 V ±500 mV.	• Replace CPU board.
18	INT-BATT CHRG FAIL	Ventilator fails internal battery charger's self-test when PV 403 is switched on (only if mains power is connected).	• Replace PGC board.

Error code	Text on LCD display	Problem	Action
19	ALARM BATT. LOW	Alarm battery voltage too low.	**1** Charge alarm battery for at least 2 hours (with mains power connected) and check battery again. **2** Replace NiMH battery on alarm board. **3** Replace alarm board.
20	MOTOR GOREF FAIL	Movement of bellows to home position times out.	**1** Replace motor assembly. **2** Replace CPU board.
21	--	Ventilator fails PIC communication test within defined time.	**1** Replace alarm board. **2** Replace CPU board.
22	MASTR MOTOR SHUT-DOWN FAIL	Ventilator fails master processor motor-shut-down test.	• Replace CPU board.
23 (Audible alarm, duration 5 s)	SLAVE MOTOR SHUT-DOWN FAIL	Ventilator fails PIC processor motor-shut-down test. Problem does not cause function failure; operation will continue after alarm.	**1** Replace alarm board. **2** Replace CPU board.
24	VALUE LOAD CHECK SUM FAIL	Ventilator's settings parameters check fails.	• Replace CPU board.
25	DATE TIME MIS MATCH	Real time clock does not function properly	• Replace CPU board
31	CPU COM. TIME-OUT FAIL	Master processor communication times out.	• Replace CPU board.
32	--	LCD display communication times out.	• Replace alarm board.
34	CPU COM FAIL	Receive buffer full.	• Replace alarm board.
35	CPU COM FAIL	PIC not ready to write on LCD.	• Replace alarm board.

Error code	Text on LCD display	Problem	Action
41	INSP. EXP. TIME FAIL	Movement of bellows to home position after inspiration has started times out.	• Replace motor assembly.
42	GAUGE MATCH FAIL	Pressure sensors do not match.	**1** Check all pressure sensor tubes. **2** Replace PGC board.
43	REM. POWER FAIL	No 12 V power to remote control or remote alarm.	**1** Check I/O board connector. **2** Replace CPU board.
44	CPU PROC. DATA FAIL	Ventilator fails critical variable RAM test. Check performed each time a critical variable is used.	• Replace CPU board.
45	CPU NVRAM LOGG FAIL	Pointers to NVRAM log memory out of range. Check performed each time a pointer is read.	• Replace CPU board.
46	CPU NVRAM CALEN FAIL	Pointers to NVRAM calendar memory are out of range. Check performed each time a pointer is read.	• Replace CPU board.
47	MOTOR TACHO METER FAIL	Motor tachometer sensor error (VCV mode only).	• Check optoswitch on motor assembly.
48	CPU PROC. OPCOD FAIL	Ventilator fails CPU processor's opcodes continuous self-test. Unused areas in CPU program memory should be filled with illegal opcode.	• Replace CPU board.
49	PGC TEMP HIGH FAIL	PGC card temperature too high. Temperature should be 75 ±5ºC.	• Check temperature.
50	INT-BATT TEMP HIGH FAIL	Internal backup battery temperature too high. Temperature should be 60 ±5ºC.	• Check temperature.
51	POWER STAGE TEMP HIGH FAIL	Mains power supply temperature too high. Temperature should be 105 ±5ºC.	• Check temperature.

Error code	Text on LCD display	Problem	Action
52	INT. BATT CHRG FAIL	Internal backup battery overcharge-protection fuse blown. Error code only displayed if mains power is present.	**1** Replace F1 on PGC board. **2** Replace PGC board.
53	MOTOR BELT SKID FAIL	Bellows driving belt skids.	**1** Replace belt on motor assembly. **2** Replace motor assembly.
54	--	PIC processor communication times out.	• Replace alarm board.
55	CPU NVRAM PARAM FAIL	NVRAM settings parameters do not match checksum. Parameters used for breath calculations should be fetched from NVRAM before start of each breath.	**1** Replace BAT1 battery on CPU board. **2** Replace CPU board.
56	TIME BASE ERROR	Ventilator fails internal software timer test (4 ms).	• Replace CPU board.
57	MAINS LOW	Mains power supply too low. Voltage should be higher than 80 V.	• Check mains power.
58	BATT LOW	External battery voltage too low. Voltage should be higher than 10.6 V or 21.2 V if no internal battery is installed.	• Charge or replace external battery.
59	BATT LOW	Internal battery voltage too low. Voltage should be higher than 21.2 V.	• Charge or replace internal battery.
60	PIC VALUE FAIL	Communications between alarm board processor and CPU board is not correct.	• Replace alarm board.
61	LOW VOLT	There are no voltage supplied to ventilator within specified limits.	• Check power supplied to ventilator.
62	INT. BATT FUSE. FAIL	Fuse on PGC board blown.	• Replace fuse.
66	GAUGE MATCH FAIL CHECK TUBE?	The patient pressure is more than 20 mbar lower than the pressure measured in bellows. The pressure in the patient circuit has to be more than 5 mbar to get this fault.	• Check green patient pressure measuring tube for leakage or water.
67	PEEP PRESS FAIL	Pressure in patient circuit is 1 mbar higher than set PEEP for more than 15 seconds.	**1** Replace exhalation valve. **2** Replace PGC board.

10 Appendices

10.1 Engineering change history

The table below lists by serial number the engineering changes made to the PV 403.

From serial number	Changes
F32000	Production start
F45000	Software change MCI/SAN On/Off function modified
F45224	C11 changed to 220 pF on CPU board
F49227	New board revisions, compatible with former boards: CPU board revision 5, PGC board revision 4, alarm board revision 4 No functional changes
F50285	Software change MCL/SAN On/Off button and Mute button not locked when keyboard is locked
N03080	New CPU board, revision 5C
N05428	Software change MCU/SAP: Modified tolerance for error code detection Alarm board with new reset circuit
N27144	New CPU board, revision 6B New Alarm board, revision 5
N34071	Software change SBC
P360431	Software change MDN
R070000	Available with option PEEP. For PV 403 PEEP the following changes was made: New CPU board, revision 7B New PGC board, revision 6B New Firmware MPA/SBD

10.2 Service record – BREAS PV 403 ventilator

Use a photocopy of this service record for the maintenance inspection described in chapter 2 “Maintenance instructions” of this service manual. Use the reverse side for comments and notes.

Service record no._____

Model:	**Serial no.**	**Inventory no.** .....
Accessories:		
Delivery date:.....	Operating hours:.....	
Service started:.....	Signature:	
Service completed:	Signature:	
Product returned:.....	Signature:	

General	**See instruction ref.**	**Check OK**
Open new service record and identify ventilator	2.3.2	.....
Note number of operating hours	2.3.3	.....
Check all markings	2.3.4	.....
Check information from user	2.3.5	.....
Check validity of documentation	2.3.6	.....
External checks		
Inspect for external damage and wear	2.4.1	.....
Check power connection	2.4.2	.....
Perform minimum function check	2.4.3	.....
Internal checks		
Clean inside of ventilator	2.5.1	.....
Check cabling	2.5.2	.....
Check fastening of components	2.5.3	.....
Motor assembly		
Check if motor assembly needs replacing after 20,000 operating hours	5.11, 5.12	.....
Replace drive belt	6.3	.....
Lubricate ball screw	6.4	.....
Replace membranes in both check valves.	6.5	.....
Electronics		
Power supply	2.5.7	.....
Calibrate pressure sensors	7	.....
Check internal/external battery operation	8.9, 8.10	
Check if alarm/clock batteries need replacing	8.11, 8.12	.....
After reassembly		
Check electrical safety levels	8.15	.....
Test motor assembly and tubes for leaks	6.6	.....

Continued on next page

Final checks before handing over

Function check	2.6.1	.....
Check low pressure/leakage alarm	2.6.2	.....
Check low volume alarm	2.6.3	.....
Check alarm mute	2.6.4	.....
Check trigger function	2.6.5	.....
Check pressure/rate	2.6.6	.....
Check tidal volume indication	2.6.7	.....
Check tidal volume (VCV)	2.6.8	.....
Check internal battery operation	2.6.10	.....
Check external battery operation	2.6.9	.....
Check accessories (where applicable)	2.6.14	.....
Replace/wash patient filters	2.6.15	.....
Adjust settings for patient	2.6.16	.....

Notes

10.3 Returning products to BREAS

You may need to return the ventilator or any components or accessories to BREAS, for example, for service, warranty, upgrade, or repair. If so, follow the instructions below to ensure that the correct action is taken and to avoid unnecessary delays.

1. Pack the product in its original packaging. If this is not available pack the product in packaging suitable for transporting it to BREAS.
2. Photocopy the delivery report on the next page.
3. Fill out the framed customer part of the service report and pack it together with the product to be returned. The service report will be completed by BREAS and returned with the product.

Product damage caused by poor packaging or during transport is not covered by the factory warranty.

10.4 Delivery report – BREAS PV 403 ventilator

BREAS ref. no.:.....

Customer information

Customer name: .....

Address:.....

.....

Phone: .....

Reference person:..... **Customer ref. no.:** .....

Product information

Model:..... **Serial no.:** ..... **Operating hours:** .....

Error – Complaint – Accessories

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

.....

Continued on next page

Date received by BREAS:..... **Signature**: .....

Repair **Warranty** **Update** **Charge** **Other**

Action taken:

.....

.....

.....

.....

.....

.....

.....

.....

Parts used: **Pcs:** **Price:**

.....

.....

.....

.....

Running hours from BREAS:..... h

Date returned to customer:..... **Signature**: .....

Notes:

.....

.....

.....

.....

.....

.....

.....

11 PV 403 SIMV OPERATING MANUAL

12 PV 403 PEEP OPERATING MANUAL